

INCH-POUND

DOE-STD-1090-96

Revision 1

September 1996

Supercedes

DOE-HDBK-1090-95

June 1995

# DOE STANDARD

## HOISTING AND RIGGING (Formerly Hoisting and Rigging Manual)



**U.S. Department of Energy**  
**Washington, D.C. 20585**

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Order No. DE97000159

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**CHAPTER 16            REFERENCES**

## **History and Background**

In 1975, cognizant safety and health personnel at the U.S. Department of Energy (DOE) Headquarters (HQ) met to discuss the need for a DOE hoisting and rigging manual. At that meeting, existing, applicable hoisting and rigging codes, standards, and regulations, such as the Occupational Safety and Health Administration (OSHA) 29 CFR 1910, the American National Standards Institute (ANSI) B-30 series, and others, were reviewed in detail. Subsequently, it was determined that these documents, while adequate as minimum general industry standards, did not contain the detail necessary to adequately accomplish the extremely complex, critical, and hazardous hoisting and rigging operations being performed at DOE sites, in all probability, at other government agency and private sectors throughout the country. Because of the high potential for accidents that could result in significant property loss or serious personnel injury or death, it was decided that a DOE hoisting and rigging manual was not only desirable but absolutely necessary.

Preliminary work on the manual was initiated in 1976. The manual that was developed at that time incorporated the minimum requirements of OSHA, ANSI, and similar documents and also included additional more stringent requirements deemed necessary to adequately control hoisting and rigging work processes throughout DOE. Each phase of the manual was then critically reviewed by DOE and contractor personnel. A final draft was completed in 1978 and implemented on a trial basis.

In June 1980, a decision was made to formally issue and distribute the manual under controlled distribution, an arrangement where the manual must be specifically requested from the originating source; however, once requested, updates are automatically received through an actively maintained distribution list. In 1982, the manual was included as a reference standard in DOE 5480.4, "Environmental Protection, Safety, and Health Protection Standards." Updates and improvements have been made over the years on an approximately annual basis. Revisions have occurred in 1984, 1985, 1986, 1988, 1989, 1993, 1995, and 1996 to clarify intent, comply with OSHA and ANSI B-30 changes, improve format, strengthen wording, delete needless redundancy, eliminate obsolescence, and the like. Prior to inclusion in the manual, all changes must be approved by the DOE Hoisting and Rigging Committee, which meets semi-annually, and by the Headquarters Office of Occupational Safety and Health Policy, which has safety responsibility for DOE hoisting and rigging. The Committee is also a major source for input into the manual, particularly concerning those areas that are not defined or are only generally defined by Federal and national standards, such as training and qualification, and those concerning the DOE's unique operational environment, such as hoisting and rigging over nuclear reactors and other locations containing critical equipment. In the years that minor revisions occur, only the changed pages, usually 8 to 10, are sent to individuals on the distribution list. After two to three such supplements, the manual is reissued in its entirety, which incorporates the previous supplements plus the most recent unpublished changes approved by the committee. An example is the complete revision issued in 1993 followed by another complete revision in 1995, without any intervening supplements. In this case, the supplements were omitted because of the numerous improvements incorporated within the very short time period. Some of the most notable changes in the current standard include:

1. Full compliance with OSHA and ANSI requirements, with the OSHA requirements having priority where conflicts exist.
2. Expansion of Chapter 6 to include greater detail on qualifications for a larger number of positions. Criteria to be evaluated in training programs have likewise been expanded, enabling sites to tailor training programs to their particular characteristics.
3. The complete reformatting of each section into major equipment categories so that the handbook is easier to use.
4. The use of double-column format along with a slightly larger font size which improves readability. The double-column format has the added advantage of placing figures and tables closer to their referencing text.
5. Labeling of the side-by-side good practice, bad practice drawings so that the information being conveyed is immediately apparent. Also, in some cases portions of drawings

containing key information, such as hand signals, finger positions were difficult to discern. These have been retouched.

6. This document contains many common element requirements which differ slightly in wording when applied to a specific equipment type. These differences have been compared, and whenever appropriate, the most comprehensive (and clearest) wording has been used.
7. To improve readability, the writing style has been changed to the active voice, which reduces, to some extent, the use of the word “shall,” indicating a mandatory requirement. The reader should note that the use of the active (imperative) voice, such as “ensure that, check for, use only,” indicates a mandatory requirement even if the word “shall” is not present in the sentence.
8. The reissued June '95 edition marked a change in classification. The DOE Office of Scientific and Technical Information (OSTI) reclassified the manual as a handbook and was issued as DOE Hoisting and Rigging Handbook (DOE-HDBK-1090-95). After further review, OSTI has reclassified the handbook as a DOE Technical Standard and the September 1996 edition is now issued as DOE STANDARD HOISTING AND RIGGING (Formerly Hoisting and Rigging Manual), DOE-STD-1090-96 (Rev-1).

While *The Hoisting and Rigging Standard* is in itself a best practice document, much of its content, such as the OSHA, ANSI/ASME, and Crane Manufacturers Association of America standards, is mandatory within DOE. In addition, many DOE organizations have, on their own initiative, adopted the standard as mandatory to ensure safe and proper hoisting and rigging operations at their facilities. Whether mandatory or not, the standard is and will continue to be the standard by which the excellence of DOE hoisting and rigging programs are judged.

## Acknowledgment

The Department of Energy (DOE) acknowledges the many organizations whose documents provided important source material for the standard. They include :

American Society of Mechanical Engineers

ANSI B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)"

ANSI B30.5, "Crawler, Locomotive, and Truck Cranes"

ANSI B30.9, "Slings"

ANSI B30.10, "Hooks"

ANSI B30.16, "Overhead Hoists (Underhung)"

ANSI B56.1, "Low Lift and High Lift Trucks"

ANSI MH11.4, "Forks and Fork Carriers for Powered Industrial Fork Lift Trucks"

Construction Safety Association (CSA) of Ontario

"The Rigging Handbook"

Society of Automotive Engineers, Inc. (SAE)

SAE J1028, "Mobile Crane Working Area Definitions"

Permission to reprint specific figures and illustrations was obtained from CSA and SAE. Applicable sections of 29 CFR 1910, "Occupational Safety and Health Standards for General Industry," and 29 CFR 1926, "Occupational Safety and Health Regulations for Construction," have been paraphrased or reproduced verbatim throughout. The contributions of DOE's Hoisting and Rigging Committee, which has met semi-annually since 1980, is also recognized. Representing many DOE sites, this group has provided advice and clarification of the codes and standards that form the underlying basis for this document. Without their time and talent, which has been provided gratuitously, there would be no standard.

Other significant contributors include the two editors, Ingeborg Westfall and Marshall Henrie, whose considerable efforts resulted in several of the substantive improvements described in the History and Background section, and whose changes regarding text, format, and spelling have improved the standard to what we believe is the equivalent of desktop-publishing quality and in doing so increased its usefulness to the hoisting and rigging community. The Department is also greatly indebted to Kay Johnson, now retired, who, during his 10-year tenure as program coordinator, perhaps more than any other person, was responsible for developing the standard into the truly invaluable document that it is today.

The standard is a safety, not a design, document intended for use by safety professionals and managers. In keeping with this philosophy, only those portions of standards and regulations dealing with safety, particularly those deemed most relevant to DOE operations, have been included. While it is convenient to have focused, indepth hoisting and rigging safety information concentrated into one document, the significance of the above source material is acknowledged, and readers are strongly encouraged to review each of them so as to have a full description of the subject area covered.

In the past, DOE issued and disseminated the *Hoisting and Rigging Standard* using controlled distribution list. Beginning with this edition, uncontrolled distribution is available through the DOE Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, telephone 423-576-8401, to Federal agencies and their contractors; and the National Technical Information Service, U.S. Department of

**DOE-STD-1090-96 (Rev-1)**

Commerce, 5285 Port Royal Road, Springfield, VA 22161, telephone 703-487-4650, to non-Federal agencies, and the private sector. These organizations charge a fee for a copy of the document. DOE appreciates the opportunity to share *The Hoisting and Rigging Standard* with a wider audience.

## Introduction

The U.S. Department of Energy (DOE) *Hoisting and Rigging Standard* is intended as a reference document to be used by supervisors, line managers, safety personnel, equipment operators, and any other personnel responsible for safety of hoisting and rigging operations at DOE sites. The standard quotes verbatim or paraphrases (with minor editorial changes for consistency) the requirements of the U.S. Occupational Safety and Health Administration (OSHA) and the American National Standards Institute (ANSI). It also encompasses, under one cover, hoisting and rigging requirements, codes, standards, and regulations, eliminating the need to maintain extensive (and often incomplete) libraries of hoisting and rigging standards throughout DOE.

As indicated in the History and Background section, the use of the imperative voice (as in “Never use discarded load chain for slings”) or the word “shall” denotes a mandatory action, whereas use of the word “should” denotes a recommended action in keeping with best management practices.

From chapter to chapter, the reader may notice what appears to be excessive repetition. Such repetition, however, is by design, enabling the use of each chapter, if needed or convenient, as a stand-alone document.

The standard occasionally goes beyond the minimum general industry standards established by OSHA and ANSI; and also delineates the more stringent requirements necessary to accomplish the extremely complex, diversified, critical, and oftentimes hazardous hoisting and rigging work found within the DOE complex. In doing so, it addresses the following items which are not covered in detail in the general industry standards:

1. Management responsibility and accountability
2. Operator/inspector training and qualification requirements
3. Definition of critical lifts and the additional requirements for making them
4. The need and responsibilities of a person-in-charge for critical lifts
5. The need and responsibilities of a designated leader for ordinary lifts
6. The definition and special requirements for preengineered production lifts
7. Special requirements for the testing, inspection, and maintenance of hoisting equipment in hostile environments
8. Nondestructive testing/nondestructive examination requirements for such items as hooks, welds, and spreader bars
9. Special requirements for inspection and load-testing of hoisting and rigging equipment/accessories
10. Hook latch requirements for cranes, slings, and rigging accessories
11. Design standards for such equipment as cranes, forklifts, and hooks
12. Operating practices for hoisting and rigging operations
13. Rigging information and load tables
14. Good and bad rigging practices.

Because the possibility of serious accidents resulting in personnel injury or death or significant property damage exists whenever hoisting and rigging take place, the requirements for these operations must be clearly defined and precautions ensured, including proper preplanning, extreme care, attention to detail, teamwork on

the part of trained operators/riggers, and the use of equipment that is reliable, properly designed, inspected, and maintained. Although not mandatory at all DOE sites and locations, this standard has been used for many years by DOE and its contractors as a valuable resource for conducting hoisting and rigging safely and efficiently and as the standard against which to judge all hoisting and rigging programs. The full implementation of the requirements and recommendations of this standard will dramatically strengthen hoisting and rigging programs throughout the DOE complex and will significantly decrease the probability of serious accidents resulting in personnel injury or death or severe property damage.

When organizations operating under nuclear energy programs are required to use DOE document NE F8-6T, those organizations shall use a combination of it and *The DOE Hoisting and Rigging Standard*. Where conflicts exist, this standard shall be given priority since it is being kept current and NE F8-6T has not been revised since 1985.

To propose improvements to the standard, please use the copy of the form at the back. All requests or suggestions for improvement should be submitted to:

Hoisting and Rigging Project Manager  
U.S. Department of Energy  
EH-51, 270 CC  
19901 Germantown Road  
Germantown, MD 20874-1290

# CHAPTER 1

## TERMINOLOGY AND DEFINITIONS

The following are specialized terms commonly used when discussing hoisting and rigging operations. Many may not be used in this standard but are included for general information. The terms are arranged in alphabetical order. Illustrations are included for clarity.

**ABRASION:** Surface wear.

**ACCELERATION STRESS:** Additional stress imposed due to increasing load velocity.

**ALTERNATE LAY:** Lay of wire rope in which the strands are alternately regular and lang lay.

**ANSI:** American National Standards Institute.

**APPOINTED:** Assigned specific responsibilities by the employer or the employer's representative.

**AREA, METALLIC:** Sum of the cross-sectional areas of individual wires in a wire rope or strand.

**ATTACHMENT:** A device other than conventional forks or load backrest extension, mounted permanently or removably on the elevating mechanism of a truck for handling the load. Popular types are fork extension clamps, rotating devices, side shifters, load stabilizers, rams, and booms.

**AUTHORIZED:** Assigned by a duly constituted administrative or regulatory authority.

**AUXILIARY HOIST:** Supplemental hoisting unit of lighter capacity and usually higher speed than the main hoist.

**BACK STAY:** Guy used to support a boom or mast or that section of a main cable, as on a suspension bridge, or cableway, and the like, leading from the tower to the anchorage.

**BAIL:** A U-shaped member of a bucket, socket, or other fitting.

**BASKET OR SOCKET:** The conical portion of a socket into which a splayed rope end is inserted and secured with zinc.

**BATTERY-ELECTRIC TRUCK:** An electric truck in which the power source is a storage battery.

**BECKET LOOP:** A loop of small rope or a strand of rope fastened to the end of a large wire rope to facilitate installation.

**BENDING STRESS:** Stress on wires of a wire rope imposed by bending. This stress need not be added to direct load stresses. When sheaves and drums are of suitable size, bending stress does not affect the normal life of the wire rope.

**BIRDCAGE:** A colloquialism describing the appearance of a wire rope that is forced into compression. The outer strands form a "cage" and at times displace the core.

**BIRDCAGING:** The twisting of fiber or wire rope in an isolated area in the opposite direction of the rope lay, causing it to take on the appearance of a birdcage.

**BOOM (CRANE):** A member hinged to the rotating superstructure and used for supporting the hoisting tackle.

**BOOM LINE:** A wire rope for supporting or operating the boom on derricks, cranes, draglines, shovels, and the like.

**BRAKE:** A device used for slowing or stopping motion by friction or electromagnetic means.

**BRAKE, DRAG:** A brake that provides stopping force without external control.

**BRAKE, HOLDING:** A brake that sets automatically and that prevents motion when power is off.

**BRAKE, PARKING:** A device to prevent the movement of a stationary vehicle.

**BRAKING, COUNTERTORQUE:** A method of stopping motion in which the power to the motor is reversed to develop torque in the opposite direction.

**BRAKING, DYNAMIC:** A method of controlling crane motor speeds when in the overhauling condition to provide a retarding force.

**BRAKING, MECHANICAL:** A method of slowing motion by friction.

**BRAKING, REGENERATIVE:** A form of dynamic braking in which the electrical energy generated is fed back into the power system.

**BREAKING STRENGTH:** The measured load required to break a wire rope or chain.

**BRIDGE:** The part of a crane, consisting of girders, walkways, railings, trucks, and drive mechanisms, that carries the trolley or trolleys.

**BRIDGE TRAVEL:** Horizontal travel of the crane parallel with runway rails.

**BRIDLE SLING:** A sling composed of multiple legs (branches), the top ends of which terminate in a fitting that latches onto the lifting hook.

**BULL RING:** The main large ring of a sling to which sling legs are attached.

**BUMPER (BUFFER):** An energy-absorbing device for reducing impact when a moving overhead crane or trolley reaches the end of its permitted travel, or when two moving cranes or trolleys come into contact.

**CAB:** The operator's compartment.

**CABLE:** A term loosely applied to wire ropes, wire strands, manila ropes, and electrical conductors.

**CABLE-LAID WIRE ROPE:** A type of wire rope consisting of several independent wire ropes laid into a single wire rope.

**CABLE CROWD ROPE:** A wire rope used to force the bucket of a power shovel into the material being handled.

**CANTILEVER TRUCK:** A self-loading counterbalanced or noncounterbalanced truck equipped with cantilever load-engaging means, such as forks (see Figure 1-1).

**CARRIAGE:** A support structure for forks or attachments, generally roller-mounted, traveling vertically within the mast of a cantilever truck.

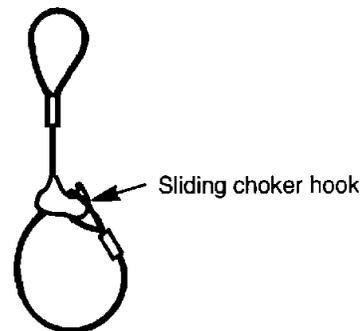
**CENTER:** A single wire or fiber in the center of a strand around which the wires are laid.

**CENTER CONTROL:** The position near the center of a truck cab from which the operator controls movement of the truck.



**Figure 1-1. Cantilever truck, counterbalanced truck, forklift truck, high-lift truck, rider truck.**

**CHOKER ROPE:** A short wire-rope sling used to form a slip noose around the object to be moved or lifted (see Figure 1-2).



**Figure 1-2. Choker rope.**

**CIRCUMFERENCE:** Measured perimeter of a circle circumscribing the wires of a strand or the strands of a wire rope.

**CLAMP, STRAND:** A fitting used to form a loop at the end of a length of strand; consists of two grooved plates and bolts.

**CLEARANCE:** The distance by which one object clears another, or the clear space between them.

**CLEVIS:** A U-shaped fitting with pins.

**CLIP:** A fitting used to clamp two parts of wire rope.

**CLOSED SOCKET:** A wire-rope fitting consisting of an integral becket and bail.

**CLOSING LINE:** Wire rope that closes a clamshell or orange-peel bucket and then operates as a hoisting rope.

**COIL:** Circular bundle of wire rope not packed on a reel.

**COLLECTOR:** Contacting device mounted on a bridge or trolley and used to collect current from the conductor system.

**COME-ALONG:** A portable, hand-operated device consisting of a housing, a length of chain or wire rope, two hooks, and a ratcheting lever, that is used for miscellaneous pulling.

**CONDUCTOR:** Wire, angles, bars, tees, or special sections mounted to transmit current to the collectors.

**CONICAL DRUM:** Grooved hoisting drum of varying diameter.

**CONSTRUCTION (WIRE ROPE):** Refers to the design of wire rope, including number of strands, number of wires per strand, and arrangement of wires in each strand.

**CONTINUOUS BEND:** Reeving of wire rope over sheaves and drums so that it bends in one direction (as opposed to reverse bend).

**CONTROLLER:** An operator's device for regulating the power delivered to a motor or other equipment.

**CONTROLLER, SPRING RETURN:** A controller that, when released, will return automatically to a neutral position.

**CORE:** The center member of a wire rope around which the strands are laid. It may be fiber, a wire strand, or an independent wire rope.

**CORING LINE:** Wire rope used to operate the coring tool for taking core samples during the drilling of a well.

**CORROSION:** Chemical decomposition by exposure to moisture, acids, alkalies, or other destructive agents.

**CORRUGATED:** A term used to describe the grooves of a sheave or drum when worn so as to show the impression of a wire rope.

**COUNTERBALANCED TRUCK:** A truck equipped with load-engaging means wherein, during normal transporting, all the load is external

to the polygon formed by the wheel contacts (see Figure 1-1).

**COVER WIRES:** The outer layer of wires.

**CRANE:** A machine used for lifting and lowering a load vertically and moving it horizontally and that has a hoisting mechanism as an integral part of it.

#### CRANES, TYPES OF:

**Automatic Crane:** A crane that, when activated, operates through a preset cycle or cycles.

**Cab-Operated Crane:** A crane controlled by an operator in a cab located on the bridge or trolley.

**Cantilever Gantry Crane:** A gantry or semigantry crane in which the bridge girders or trusses extend transversely beyond the crane runway on one or both sides.

**Floor-Operated Crane:** A crane whose operation is controlled by use of a pendant in the hands of an operator on the floor or on an independent platform.

**Gantry Crane:** A crane similar to an overhead crane, except that the bridge for carrying the trolley or trolleys is rigidly supported on two or more legs running on fixed rails or other runway.

**Jib Crane:** A fixed crane with a vertical rotating member supported at the bottom (also at the top in some types) from which an arm extends to carry the hoist trolley. Jib cranes are most commonly mounted on a vertical column, supplied as part of the jib crane, or on existing structural members (e.g., a wall-mounted jib crane).

**Overhead Traveling Crane:** A crane with a movable bridge carrying a movable or fixed hoisting mechanism and traveling on an overhead fixed-runway structure.

**Power-Operated Crane:** A crane whose mechanism is driven by electricity, air, hydraulics, or internal combustion.

**Pulpit-Operated Crane:** A crane operated from a fixed operator station that is not attached to the crane.

**Remote-Operated Crane:** A crane controlled by an operator not in a pulpit or a cab attached to the crane, by any method other than pendant or rope control (e.g., radio-controlled crane).

**Semigantry Crane:** A gantry crane with one end of the bridge rigidly supported on one or more legs that run on a fixed rail or runway, the other end of the bridge being supported by a truck running on an elevated rail or runway.

**Wall-Mounted Crane:** A crane having a jib, with or without a trolley, supported from a side wall or line of columns of a building. It is a traveling-type crane and operates on a runway attached to the side wall or line of columns.

**Wall-Mounted Jib Crane:** See Cranes, Types Of, Jib Crane.

**CRITICAL DIAMETER:** Diameter of the smallest bend for a given wire rope that permits the wires and strands to adjust themselves by relative movement while remaining in their normal positions.

**CRITICAL ITEM:** A part, assembly, component, or piece of equipment designated as critical by a purchaser or facility operator, because the dropping, upset, or collision of it could: (a) cause damage that would result in schedule delay, (b) cause undetectable damage that could jeopardize future operation or the safety of the facility, (c) result in significant release of radioactivity or other undesirable condition, or (d) present a potentially unacceptable risk of personnel injury or property damage. Critical items may include pumps, heat exchangers, piping subassemblies, other primary-system components, fuel assemblies, large radiation-shielded shipping casks, or other items that require special care in handling because of size, weight, installation in close-tolerance receptors, fragility, extreme susceptibility to damage, or other unusual factors.

**CRITICAL SERVICE:** The use of equipment or tackle for hoisting, rigging, or handling of critical items.

**CYLINDRICAL DRUM:** Hoisting drum of uniform diameter.

**DECELERATION STRESS:** Additional stress imposed on a wire rope due to decreasing the load velocity.

## DEFLECTION:

- o Sag of a rope in a span, usually measured at midspan as the depth from a chord joining the tops of the two supports.
- o Any deviation from a straight line.

**DESIGN FACTOR:** Ratio of ultimate strength to the design working stress.

**DESIGNATED:** Selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

**DESIGNATED LEADER:** "An individual assigned responsibility for hoisting and rigging activities requiring more than one person".

**DIAMETER:** Distance measured across the center of a circle circumscribing the wires of a strand or the strands of a wire rope.

**DIESEL-ELECTRIC TRUCK:** An electric truck in which the power source is a generator driven by a diesel engine.

**DOCKBOARD:** A portable or fixed device for spanning the gap or compensating for the difference in level between loading platforms and carriers.

**DOG-LEG:** Permanent short bend or kink in a wire rope caused by improper use.

**DRAGLINE:** Wire rope used to pull an excavating or drag bucket.

**DRIVE:** Motor, coupling, brake and gear case, or gear cases used to propel bridge, trolley, or hoist.

**DRIVE GIRDER:** A girder on which is mounted the bridge drive, cross shaft, walk, railing, and operator's cab.

**DRUM:** A cylindrical-flanged barrel of uniform (cylindrical drum) or tapering (conical drum) diameter on which a wire rope is wound for operation or storage. It may be smooth or grooved.

**ELASTIC LIMIT:** Limit of stress beyond which a permanent deformation takes place within the material. This limit is approximately 55–65 percent of breaking strength of steel-wire ropes.

**ELECTRIC TRUCK:** A truck in which the principal energy is transmitted from power source to motor(s) in the form of electricity.

**END CONTROL:** An operator-control position that is located at the end opposite the load end of the truck.

**EQUALIZER:** A device used to compensate for unequal length or stretch of a hoist rope.

**EQUALIZING SLINGS:** Slings composed of wire rope and equalizing fittings.

**EQUALIZING THIMBLES:** A special type of fitting used as a component part of some wire-rope slings.

**EYE OR EYE SPLICE:** A loop with or without a thimble formed in the end of a wire rope.

**FAIL-SAFE:** A provision designed to automatically stop or safely control any motion in which a malfunction could occur.

**FATIGUE:** A term commonly applied to progressive fracture of any load-supporting member.

**FIBER CENTERS:** Cords or rope made of vegetable fiber used in the center of a strand.

**FIBER CORES:** Cords or rope made of vegetable fiber used in the core of a wire rope.

**FIRST POINT:** The first setting on the operator's controller that starts crane motion (slowly) in each direction.

**FITTING:** Any accessory used as an attachment for wire rope.

**FLAG:** Mark or marker on a rope to designate position of load.

**FLAT ROPE:** Wire rope made of parallel alternating right-lay and left-lay ropes sewn together by relatively soft wires.

**FLATTENED STRAND ROPE:** A wire rope with either oval or triangular strands that present a flattened rope surface.

**FLEET ANGLE:** Angle between the position of a rope at the extreme end wrap on a drum and a line drawn perpendicular to the axis of the drum through the center of the nearest fixed sheave.

**FORKS:** Horizontal tine-like projections, normally suspended from the carriage, used to engage and support loads.

**FORK HEIGHT:** The vertical distance from the floor to the load-carrying surface adjacent to the

heel of the forks with the mast vertical, and in the case of reach trucks, with the forks extended.

**FORKLIFT TRUCK:** A high-lift self-loading truck equipped with load carriage and forks for transporting and tiering loads (see Figure 1-1).

**GALVANIZE:** To coat with zinc to protect against corrosion.

**GALVANIZED ROPE:** Rope made of galvanized wire.

**GALVANIZED STRAND:** Strand made of galvanized wire.

**GALVANIZED WIRE:** Wire coated with zinc.

**GAS-ELECTRIC TRUCK:** An electric truck in which the power source is a generator driven by an LP-gas or gasoline engine.

**GROMMET:** A seven-strand wire-rope sling made from one continuous length of strand or an endless synthetic-web sling.

**GROOVED DRUM:** Drum with grooved outer surface to accommodate and guide a rope.

**GROOVES:** Depressions in the outer surface of a sheave or drum for positioning and supporting a rope.

**GUY LINE:** Strand or rope, usually galvanized, for holding a structure in position.

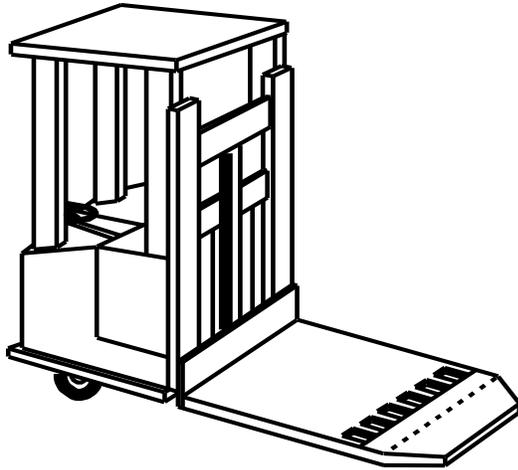
**HANDLING FIXTURE:** A cradle, structure, shipping fixture, or container designed specifically to facilitate supporting, lifting, or handling a component during fabrication, loading, shipping, storage, or installation.

**HIGH-LIFT TRUCK:** A self-loading truck equipped with an elevating mechanism designed to permit tiering. Popular types are high-lift platform trucks (see Figures 1-1 and 1-3).

**HIGH-LIFT PLATFORM TRUCK:** A self-loading truck equipped with an elevating mechanism intended primarily for transporting and tiering loaded skid platforms (see Figure 1-3).

**HOIST:** A device that applies a force for lifting or lowering.

**HOIST, LEVER OPERATED:** A lever-operated manual device used to lift, lower, or pull a load and to apply or release tension.



**Figure 1-3. High-lift truck, high-lift platform truck.**

**HOLDING LINE:** Wire rope on a clamshell or orange-peel bucket that holds the bucket while the closing line is released to dump the load.

**HOOK LOAD:** The total live weight supported by the hook of a crane, derrick, or other hoisting equipment, including the load, slings, spreader bars, and other tackle not part of the load but supported by the hook and required for the handling of the load.

**IDLER:** Sheave or roller used to guide or support a rope.

**INDEPENDENT WIRE-ROPE CORE:** Wire rope used as the core of a larger rope.

**INNER WIRES:** All wires of a strand except surface or cover wires.

#### **INTERNAL-COMBUSTION ENGINE**

**TRUCK:** A truck in which the power source is a gas or diesel engine.

**INTERNALLY LUBRICATED:** Wire rope or strand having all wires coated with lubricant.

**KINK:** Permanent distortion of wires and strands resulting from sharp bends.

**LAGGING:** External wood covering on a reel of rope or a strand.

**LANG-LAY ROPE:** Wire rope in which the wires in the strands and the strands in the rope are laid in the same direction.

**LAY LENGTH:** The lengthwise distance on a wire rope in which a strand makes one complete turn around the rope's axis (see Figure 1-4).



**Figure 1-4. Rope lay.**

#### **Left Lay:**

- o **Strand:** Strand in which the cover wires are laid in a helix having a left-hand pitch, similar to a left-hand screw.
- o **Rope:** Rope in which the strands are laid in a helix having a left-hand pitch, similar to a left-hand screw.

#### **Right Lay:**

- o **Strand:** Strand in which the cover wires are laid in a helix having a right-hand pitch, similar to a right-hand screw.
- o **Rope:** Rope in which the strands are laid in a helix having a right-hand pitch, similar to a right-hand screw.

#### **LIFT:**

- o Maximum safe vertical distance through which a hook can travel.
- o The hoisting of a load.

**LIFT, CRITICAL:** Lifting of parts, components, assemblies, or other items designated as critical because the effect of dropping, upset, or collision of them could:

- o Present a potentially unacceptable risk of personnel injury or property damage.
- o Result in significant release of radioactivity or other undesirable conditions
- o Cause undetectable damage resulting in future operational or safety problems
- o Cause significant work delay

**LIFT, ORDINARY:** Any lift not designated as a critical lift or a preengineered production lift.

**LIFT, PREENGINEERED PRODUCTION:**

Repetitive, production-type lifting operation, independent of the nature of the load to be lifted, in which the probability of dropping, upset, or collision is reduced to a level acceptable to the responsible manager by preliminary engineering evaluation, specialized lifting fixtures, detailed procedures, operation-specific training, and independent review and approval of the entire process.

**LINE:** A rope used for supporting and controlling a suspended load.

**LOAD:** The total weight superimposed on the load block or hook.

**LOAD BLOCK:** The assembly of hook or shackle, swivel, bearing, sheaves, pins, and frame suspended by the hoisting ropes.

**LOAD-BACKREST EXTENSION:** A device extending vertically from the fork carriage frame.

**LOAD-BEARING PARTS:** Any part of a material-handling device in which the induced stress is influenced by the hook load. A *primary* load-bearing part is a part the failure of which could result in dropping, upset, or uncontrolled motion of the load. Load-bearing parts which, if failed, would result in no more than stoppage of the equipment without causing dropping, upset, or loss of control of the load are not considered to be primary load-bearing parts.

**LOAD CENTER (FORKLIFTS):** The horizontal longitudinal distance from the intersection of the horizontal load-carrying surfaces and vertical load-engaging faces of the forks (or equivalent load-positioning structure) to the center of gravity of the load.

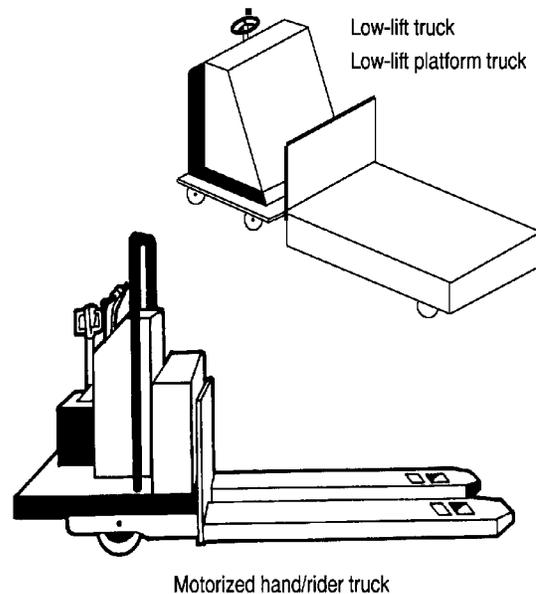
**LOW-LIFT TRUCK:** A self-loading truck equipped with an elevating mechanism designed to raise the load only sufficiently to permit horizontal movement (see Figure 1-5).

**MAGNET:** An electromagnetic device carried on a crane hook and used to pick up loads.

**MAIN HOIST:** The hoist mechanism provided for lifting the maximum-rated load.

**MAN TROLLEY:** A trolley having an operator's cab attached to it.

**MARLINE SPIKE:** Tapered steel pin used in splicing wire rope.



**Figure 1-5. Low-lift trucks.**

**MESSENGER STRAND:** Galvanized strand or bronze strand used to support telephone and electrical cables.

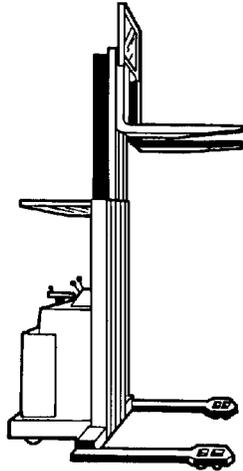
**MODULUS OF ELASTICITY:** Mathematical quantity giving the ratio, within the elastic limit, between a definite range of unit stress on a wire rope and the corresponding elongation.

**MOUSING:** A method of bridging the throat opening of a hook to prevent the release of load lines and slings, under service or slack conditions, by wrapping with soft wire, rope, heavy tape, or similar materials.

**NARROW-AISLE TRUCK:** A self-loading truck intended primarily for right-angle stacking in aisles narrower than those normally required by counterbalanced trucks of the same capacity (see Figure 1-6).

**NONDESTRUCTIVE EXAMINATION (NDE):** The development and application of technical methods to examine materials or components, in ways that do not impair future usefulness and serviceability, in order to detect, locate, measure, and evaluate discontinuities, defects, and other imperfections; to assess integrity, properties, and composition; and to measure geometrical characteristics.

**NONDESTRUCTIVE TESTING (NDT):** See NONDESTRUCTIVE EXAMINATION.

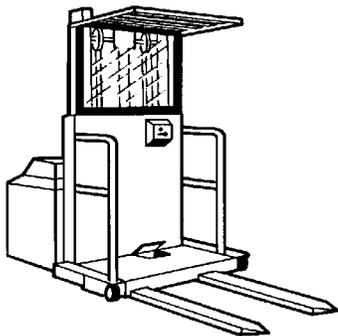


**Figure 1-6. Narrow-aisle truck.**

**NONROTATING WIRE ROPE:** See Rotation-Resistant Wire Rope.

**OPEN SOCKET:** A wire-rope fitting consisting of a basket and two ears with a pin.

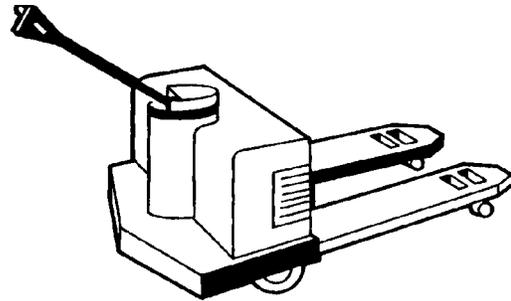
**ORDER-PICKER TRUCK, HIGH-LIFT:** A truck, controllable by an operator stationed on a platform, which is movable, has a load-engaging means, and is intended for (manual) stock selection. The truck may be capable of self-loading and/or tiering (see Figure 1-7).



**Figure 1-7. Order picker truck, high-lift.**

**OVERHEAD GUARD:** A framework fitted to a truck over the head of a riding operator.

**PALLET TRUCK:** A self-loading, nonmotorized or motorized low-lift truck equipped with wheeled forks of dimensions sized to go between the top and bottom boards of a double-faced pallet, the wheels fitting into spaces between the bottom boards, so as to raise the pallet off the floor for transporting (see Figure 1-8).



**Figure 1-8. Pallet truck, motorized hand truck.**

**PEENING:** Permanent distortion of outside wire in a rope caused by pounding.

**PERSON-IN-CHARGE:** The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads and for the safe handling of noncritical items in, around, or above spaces in which critical items are located.

**POWERED INDUSTRIAL TRUCK:** A mobile, power-driven vehicle used to carry, push, pull, lift, stack, or tier material.

**PREFORMED WIRE ROPE:** Wire rope in which the strands are permanently shaped, before being fabricated into the rope, to the helical form they assume in the wire rope.

**PREFORMED STRAND:** Strand in which the wires are permanently shaped, before being fabricated into the strands, to the helical form they assume in the strand.

**PRESTRESSING:** Stressing a wire rope or strand before use under such a tension and for such a time that stretch that would otherwise occur once the load is picked up is largely nonexistent.

**PROOF TEST:** A nondestructive tension test performed to verify construction and workmanship of slings or rigging accessories.

**PUBLIC CARRIER:** A for-hire company engaged in the public transportation of goods.

**QUALIFIED:** A person who, by possession of a recognized degree, certificate, or professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated an ability and competence to solve or resolve problems relating to the subject matter and work.

**QUALIFIED ENGINEER/QUALIFIED ENGINEERING ORGANIZATION:** An engineer or engineering organization whose competence in evaluation of the type of equipment in question has been demonstrated to the satisfaction of the responsible manager.

**QUALIFIED INSPECTOR:** One whose competence is recognized by the responsible manager and whose qualification to perform specific inspection activities has been determined, verified, and attested to in writing.

**QUALIFIED OPERATOR:** One who has had appropriate and approved training, including satisfactory completion of both written and operational tests to demonstrate knowledge, competence, and skill, in the safe operation of the equipment to be used.

**QUALIFIED RIGGER:** One whose competence in this skill has been demonstrated by experience satisfactory to the appointed person.

NOTE: The term “rigger” or “qualified rigger” in this standard refers to the function performed, and in no way relates to the worker's classification in any union or bargaining unit.

**RATED CAPACITY:** The maximum hook load that a piece of hoisting equipment is designed to carry; also the maximum load that an industrial truck or a sling, hook, shackle, or other rigging tackle is designed to carry.

NOTE: At the option of the user, a rated capacity can be assigned that is less than the design-rated capacity.

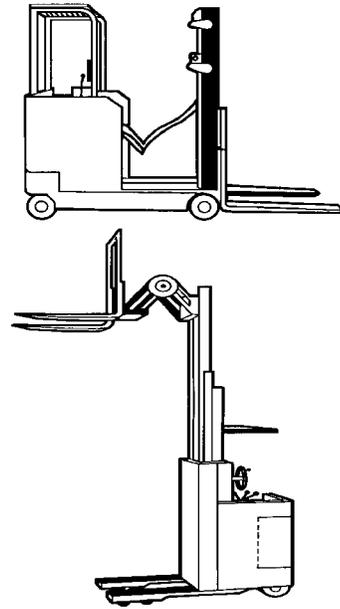
**REACH TRUCK:** A self-loading truck, generally high-lift, having load-engaging means mounted so it can be extended forward under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Figure 1-9).

**REEL:** The flanged spool on which wire rope or strand is wound for storage or shipment.

**REEVING:** A system in which a rope travels around drums or sheaves.

**REGULAR-LAY ROPE:** Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.

**REVERSE BEND:** Reeving of a wire rope over sheaves and drums so that it bends in opposite directions.



**Figure 1-9. Reach trucks.**

**RIDER TRUCK:** A truck that is designed to be controlled by a riding operator.

**RIGGING:** The hardware or equipment used to safely attach a load to a lifting device. The art or process of safely attaching a load to a hook by means of adequately rated and properly applied slings and related hardware.

**ROLLERS:** Relatively small-diameter cylinders or wide-faced sheaves used for supporting or guiding ropes.

**ROTATION-RESISTANT WIRE ROPE:** Wire rope consisting of a left-lay, lang-lay inner rope covered by right-lay, regular-lay outer strands.

**RUNNING SHEAVE:** A sheave that rotates as the load block is raised or lowered.

**RUNWAY:** Assembly of rails, girders, brackets, and framework on which a crane operates.

**SAFE WORKING LOAD:** Load that a rope may carry economically and safely.

**SEALE:** A strand construction having one size of cover wires with the same number of one size of wires in the inner layer and each layer having the same length and direction of lay. Most common construction is one center wire, nine inner wires, and nine cover wires.

**SEIZE:** To securely bind the end of a wire rope or strand with seizing wire or strand.

**SEIZING STRAND:** Small strand, usually of seven wires, made of soft-annealed-iron wire.

**SEIZING WIRE:** A soft-annealed-iron wire.

**SELF-LOADER:** A truck with tires that can fit between the top and bottom boards of a double-faced pallet.

**SERVE:** To cover the surface of a wire rope or strand with a wrapping of wire.

**SHACKLE:** A type of clevis normally used for lifting (see Figure 1-10).

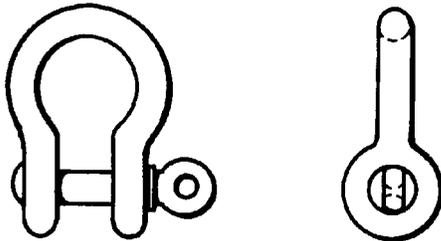


Figure 1-10. Shackle.

**SHALL:** A word indicating that an action is mandatory.

**SHEAVE:** A grooved wheel or pulley used with a rope to change direction and point of application of a pulling force.

**SHEAVE, NONRUNNING (EQUALIZER):** A sheave used to equalize tension in opposite parts of a rope, called nonrunning because of its slight movement.

**SHEAVE, RUNNING:** A sheave that rotates as the load block is lifted or lowered.

**SHOULD:** A word indicating a recommended action, the advisability of which depends on the facts in each situation.

**SIDE LOADER:** A self-loading truck, generally high-lift, having load-engaging means mounted in such a manner that it can be extended laterally under control to permit a load to be picked up and deposited in the extended position and transported in the retracted position (see Figure 1-11).

**SIDE PULL:** That portion of a hoist pull acting horizontally when the hoist lines are not operated vertically.

**SLINGS:** Wire ropes, chains, synthetic web, and metal mesh made into forms, with or without fittings, for handling loads.

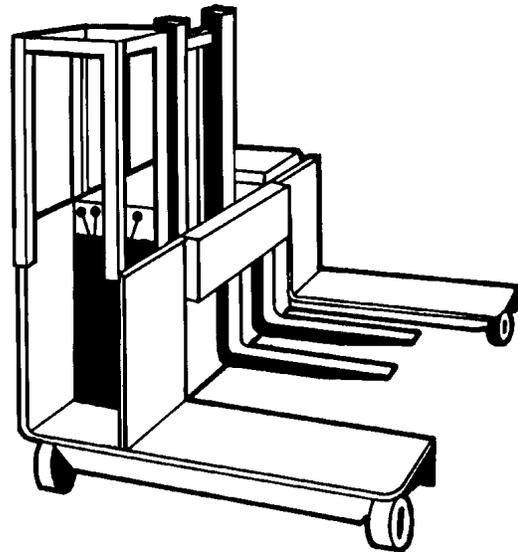


Figure 1-11. Side-loader truck.

**SLINGS, BRAIDED:** Very flexible slings composed of several individual wire ropes braided together.

**SMOOTH-FACED DRUM:** Drum with a plain, not grooved, face.

**SPAN:** The horizontal, center-to-center distance of runway rails.

**SPIRAL GROOVE:** Groove that follows the path of a helix around a drum, similar to the thread of a screw.

**SPLICING:** Interweaving of two ends of rope to make a continuous or endless length without appreciably increasing the diameter. Also refers to making a loop or eye in the end of a rope by tucking the ends of the strands.

**Splice, Hand Tucked:** A loop or eye formed in the end of a rope by tucking the end of the strands back into the main body of the rope in a prescribed manner.

**Splice, Mechanical:** A loop or eye formed in the end of a wire rope by pressing or swaging one or more metal sleeve over the wire rope junction.

**STAINLESS-STEEL ROPE:** Wire rope made of chrome-nickel steel wires having great resistance to corrosion.

**STEEL-CLAD ROPE:** Rope with individual strands spirally wrapped with flat steel wire.

**STRAND:** An arrangement of wires helically laid about an axis or another wire or fiber center to produce a symmetrical section.

**SWAGED FITTINGS:** Fittings in which wire rope is inserted and attached by a cold-forming method.

**SWITCH, ELECTRIC:** A device for making, breaking, or changing the connections in an electrical circuit.

**SWITCH, EMERGENCY STOP:** A manually or automatically operated electric switch to cut off electric power independently of the regular operating controls.

**SWITCH, LIMIT:** A switch that is operated by some part or motion of a power-driven machine or equipment to alter the electrical circuit associated with the machine or equipment.

**SWITCH, MAIN:** A switch controlling the entire power supply to a crane or other equipment, often called the disconnect switch.

**TAG LINE:** A rope used to prevent rotation of a load.

**TAPERING AND WELDING:** Reducing the diameter of the end of a wire rope and welding it to facilitate reeving.

**THIMBLE:** Grooved metal fitting to protect the eye of a wire rope (see Figure 1-12).

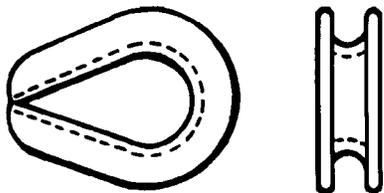


Figure 1-12. Thimble.

**TIERING:** The process of placing one load on or above another.

**TINNED WIRE:** Wire coated with tin.

**TROLLEY:** A unit consisting of frame, trucks, trolley drive, and hoisting mechanism moving on the bridge rails in a direction at right angles to the crane runway.

**TROLLEY GIRTS:** Structural members that are supported on the trolley trucks and that contain the upper sheave assemblies.

**TROLLEY TRAVEL:** Horizontal travel of a trolley at right angles to runway rails.

**TROLLEY TRUCK:** An assembly consisting of wheels, bearings, axles, and structural-supporting hoist mechanism and load girts.

**TRUCK, POWERED INDUSTRIAL:** A mobile, power-propelled truck used to carry, push, pull, lift, stack, or tier material (see Figures 1-1, 1-3, 1-5, 1-6, 1-7, 1-8, 1-9, and 1-11).

**TURNBUCKLE:** A device attached to wire rope for making limited adjustments in length. It consists of a barrel and right- and left-hand threaded bolts.

**TWO-BLOCKING:** The act of continued hoisting in which the load-block and head-block assemblies are brought into physical contact, thereby preventing further movement of the load block and creating shock loads to the rope and reeving system.

**VERIFICATION:** A procedure in which a design, calculation, drawing, procedure, instruction, report, or document is checked and signed by one or more parties. The one or more persons designated to sign verify, based on personal observation, certified records, or direct reports, that a specific action has been performed in accordance with specified requirements.

**WEDGE SOCKET:** Wire-rope fitting in which the rope end is secured by a wedge.

**WHEEL BASE:** Distance between centers of outermost wheels for bridge and trolley trucks.

**WHEEL LOAD:** The load on any wheel with the trolley and lifted load (rated load) positioned on the bridge to give maximum-loading conditions.

**WIRE ROPE:** Wire strands laid helically around an axis or a core.

**WIRE (ROUND):** Single continuous length of metal, cold drawn from a rod.

**WIRE (SHAPED):** A single continuous length of metal either cold drawn or cold rolled from a rod.

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# CHAPTER 2

## CRITICAL LIFTS

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This chapter provides guidelines for critical-lift determination and requirements for planning and performing a critical lift safely and judiciously.

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## 2.1 CRITICAL-LIFT DETERMINATION

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a. An appointed person shall classify each lift into one of the DOE categories (ordinary, critical, or preengineered production) prior to planning the lift.

b. A lift shall be designated as a critical lift if collision, upset, or dropping could result in any one of the following:

1. Unacceptable risk of personnel injury or significant adverse health impact (onsite or offsite).

2. Significant release of radioactive or other hazardous material or other undesirable conditions.

3. Undetectable damage that would jeopardize future operations or the safety of a facility.

4. Damage that would result in unacceptable delay to schedule or other significant program impact such as loss of vital data.

c. A lift should also be designated as critical if the load requires exceptional care in handling because of size, weight, close-tolerance installation, high susceptibility to damage, or other unusual factors.

## 2.2 CRITICAL-LIFT REQUIREMENTS

- a. Ensure that the requirements are met for ordinary lifts specified in each section of this standard for each particular equipment category.
- b. The operating organization shall appoint a PIC for the entire operation. This person shall meet the definitions of appointed, designated, and qualified as described in Chapter 1, "Terminology and Definitions," and shall be present at the lift site during the entire lifting operation.
- c. The PIC shall ensure that a pre-job plan or procedure is prepared that defines the operation and includes the following:
1. Identification of the items to be moved, the weight, dimensions, and center of gravity of the load, and any hazardous or toxic materials that are present
  2. Identification of operating equipment to be used by type and rated capacity
  3. Rigging sketches that include (as applicable):
    - i. Identification and rated capacity of slings, lifting bars, rigging accessories, and below-the-hook lifting devices.
    - ii. Load-indicating devices.
    - iii. Load vectors.
    - iv. Lifting points.
    - v. Sling angles.
    - vi. Boom and swing angles.
    - vii. Methods of attachment.
    - viii. Crane orientations.
    - ix. Other factors affecting equipment capacity.
4. Operating procedures and special instructions to operators including rigging precautions and safety measures to be followed as applicable.
- d. Experienced operators who have been trained and qualified to operate the specific equipment to be used shall be assigned to make the lift.
- e. Only designated, qualified signalers shall give signals to the operator. However, the operator shall obey a STOP signal at all times, no matter who gives the signal.
- f. The procedure and rigging sketches shall be reviewed and approved by the responsible manager (or designee) and the responsible oversight organization (such as safety, quality assurance, or quality control) before the lift is made.
- g. A pre-lift meeting involving participating personnel shall be conducted prior to making a critical lift. The critical lift plan/procedure shall be reviewed and questions shall be resolved.

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# CHAPTER 3

## PREENGINEERED PRODUCTION LIFTS

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This chapter provides requirements for the design, evaluation, and performance of preengineered production lifts. This lift designation may be used at the discretion of the contractor for selected operations.

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## 3.1 GENERAL

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a. A preengineered production lift is a repetitive, production-type lifting operation that is independent of the nature of the load to be lifted. Also, the probability of collision, upset, or dropping is reduced to a level acceptable to the responsible manager by preliminary operation evaluation, specialized lifting fixtures, detailed procedures, operation-specific training, and performance of independent review and approval

of the entire process.

b. The preengineered production lift is a specialized lift performed by production personnel. The required procedures and controls ensure the safety of the operation and set this category of lift apart from traditional hoisting and rigging activities.

---

## 3.2 OPERATION EVALUATION

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The following procedure should be used to determine if a lifting operation qualifies as a preengineered production lift.

### 3.2.1 Load Identification

- a. Identify the identical items or group(s) of identical items to be repetitively lifted. Items must have the same dimensions, weight, and center of gravity to be considered identical.
- b. Determine the dimensions, weight, center of gravity, and method of attachment of the items.

### 3.2.2 Task Determination

- a. Determine the parameters of motion using the following as applicable:
  1. Lifting, rotation, speeds, and travel directions.

2. Actions required with or adjacent to the load.
3. Other lifting operation details that affect safety and stability of the load.

### 3.2.3 Hazards Evaluation

Determine the consequences that could result from collision, upset, or dropping the load.

### 3.2.4 Equipment/Rigging Selection

- a. Determine the type, class, and minimum capacity of lifting equipment (hoist, crane, forklift, etc.) required for the operation based on the identified load, task, and hazards.
- b. Define the type of lifting fixtures required to safely accomplish the required task.

## 3.3 LIFTING FIXTURES

### 3.3.1 Design

c. Special lifting fixtures and rigging accessories shall be designed according to recognized consensus standards (29 CFR 1910, Occupational Safety and Health Standards for General Industry; 29 CFR 1926, Occupational Safety and Health Regulations for Construction; ASME B30.9, “Slings,” B30.10, “Hooks,” B30.20, “Below-the-Hook Lifting Devices”; etc.) and the lifting fixture design requirements in Chapters 12 and 14 (“Rigging Accessories” and “Below-the-Hook Lifting Devices,” respectively).

d. The designer of special lifting fixtures shall be:

1. A member of a qualified engineering organization.
2. Qualified in machine design.
3. Knowledgeable of special lifting fixture design requirements.

e. The designer shall determine the requirements for initial and periodic inspections or tests, including acceptance/rejection criteria and periodic inspection/test intervals.

f. Special lifting fixture designs shall receive a documented review by another member of a qualified engineering organization and the responsible oversight organizations (safety, quality assurance, etc.).

g. Deviations in design that may result in design factors less than consensus standard requirements shall require documented justification and approval of the designer's manager and the manager of the responsible oversight organizations (safety, quality assurance, etc.).

h. Applications not specifically addressed in the ASME standards or in this standard may be approved by the responsible manager and oversight organizations (safety, quality assurance, etc.) when justification and documentation are provided and all other provisions of this section are met.

### 3.3.2 Fabrication

Special lifting fixtures shall be fabricated according to the specifications of the approved design package.

### 3.3.3 Inspection and Testing

a. Before initial use of each special lifting fixture, a qualified inspector shall perform a documented acceptance inspection and test on it. This process shall include:

1. Verification of configuration of the fixture against the design drawing specifications.
2. Nondestructive examination as specified in the approved design package.
3. Proof-testing as specified in the approved design package.

b. Personnel performing the lift shall visually inspect special lifting fixtures before use for visible signs of wear, deformation, deterioration, or damage. Records are not required.

c. A qualified inspector shall conduct periodic, documented inspections as required by the design organization. These inspections shall include preuse inspection requirements (visible signs of wear, deformation, deterioration, or damage) and a formal verification of the current configuration of the fixture against that specified in the approved design package.

d. Equipment to be used (cranes, hoists, forklifts, etc.) shall be inspected according to the appropriate section requirements in this standard for that type of equipment.

### 3.3.4 Storage, Maintenance, and Control

a. Lifting fixture users shall do the following:

1. Store special lifting fixtures in an appropriate location to prevent damage or deterioration.

2. Perform and document periodic preventive maintenance as required by the design organization.

3. Establish controls to ensure that special lifting fixtures are used only in the operations for which they were designed.

4. Maintain equipment to be used (cranes, hoists, forklifts, etc.) according to the appropriate section requirements in this standard for that type of equipment.

### 3.3.5 Modification and Repair

a. Modification to special lifting fixtures shall be designed, approved, and fabricated according to Sections 3.3.1 and 3.3.2 (“Design,” and “Fabrication,” respectively).

b. Following modification or repair of a load-bearing element of a special lifting fixture, the fixture shall be inspected and tested according to the initial use requirements in Section 3.3.3, “Inspection and Testing.”

## 3.4 PROCEDURES

A detailed, approved, step-by-step procedure shall be developed for the entire operation.

### 3.4.1 Content

- a. At a minimum, each procedure shall contain the following information:
1. Identification of the load to be lifted.
  2. Identification of the specific lifting fixtures to be used in the operation.
  3. Identification by class and capacity (if applicable) of the types of equipment to be used, such as cranes and hoists.
  4. Verification that all equipment, fixtures, and accessories are operative, up-to-date on required periodic inspections and maintenance, and are in good condition before the operation begins.
  5. Specific instructions for attachment of the lifting fixtures to the load and to the lifting equipment.
  6. Parameters of motion required for the operation.
  7. Specific instructions for removal of the lifting fixtures from both the load and the lifting equipment.

### 3.4.2 Development

- a. The methods for developing new procedures, including standard procedure formats, should be clearly defined. Administrative procedures or writers guides should direct the development and review process for procedures at each site to ensure consistency at the site.
- b. Qualifications for procedure writers shall be considered, including operating organization and experience.
- c. Procedures should reference applicable source documents, such as facility design

documents, safety analysis documents, vendor technical manuals, and industry standards.

- d. Operating procedures should contain only one action per step.
- e. Any necessary warnings, cautions, or notes should be easily identifiable and should not contain any action statements. These items should precede the step to which they apply and should appear on the same page as the step to which they apply.
- f. The sequence of procedural steps should conform to the normal or expected operational sequence.
- g. Procedures should be developed with consideration for the human-factor aspects of their intended use. For example, references to components should exactly match drawing and label-plate identifiers, and units should be the same as those marked on applicable instrumentation. Important factors should be highlighted, such as operating limits, warnings, and cautions.

### 3.4.3 Preparation and Revision

- a. Appropriately trained personnel shall develop, review, and approve a step-by-step procedure for each lifting operation. The responsible oversight organizations (safety, quality assurance, etc.) shall participate in the review process.
- b. Before its first use in the actual production process, the procedure shall undergo a formal verification and validation process using walk-throughs or similar methods to ensure that the steps are appropriate and correct. Any discrepancies found during this process shall be corrected and the process repeated until the procedure is correct.
- c. Any changes to an existing, approved procedure shall be performed according to the process specified above. The change shall be evaluated to determine whether the revised procedure must be revalidated and reverified.

### 3.4.4 Approval

a. Before each procedure is validated, it shall be reviewed and approved by the following personnel:

1. Author of the procedure.
2. Representative of a qualified engineering organization.
3. Representatives of the responsible oversight organizations (e.g., safety, quality assurance).

b. After each procedure is validated, it shall be reviewed and approved by the following personnel:

1. Author of the procedure.
2. Representative of a qualified engineering organization.
3. Representatives of the responsible oversight organizations (i.e., safety, quality assurance).
4. Management of the facility where the procedure will be performed.
5. Management of the production organization performing the procedure.

c. Revisions of procedures shall receive the same depth of review and level of approval as the initial versions received.

All procedures, either new or revised, shall be approved before use.

### 3.4.5 Review

a. Approved procedures should be reviewed at periodic intervals to ensure that their information and instructions are technically accurate and that appropriate human-factor considerations have been included.

b. The frequency of reviews should be specified for each procedure; it may vary with the type and complexity of the activity involved.

c. Applicable procedures should be reviewed after an incident.

d. During each review, procedures should be compared to source documents to verify their accuracy.

### 3.4.6 Use

a. A copy of the current issue of the approved procedure shall be in the work area when the operation is performed.

b. Deviations from the approved procedure are not allowed during normal operations.

c. The requirements for use of procedures should be clearly defined and understood by all personnel.

d. If a procedure is determined to be deficient, a procedure change shall be initiated before operations continue.

e. Personnel performing the procedure may take whatever action is necessary during emergency conditions to return the process to a safe and stable condition without first initiating a procedure change.

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## 3.5 DESIGNATED LEADER

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- a. Each time a preengineered production lift requiring more than one person is performed, a designated leader shall be present at the lift site during the entire operation.
- b. Leadership designation may be by written instructions, specific verbal instruction for the particular job, or clearly defined responsibilities within the crew's organizational structure.
- c. The designated leader's responsibility shall include the following:
  1. Ensure that the personnel involved have received proper and current training and qualification for the procedure.
  2. Ensure that the equipment and accessories specified in the procedure are available.
  3. Survey the lift site for hazardous or unsafe conditions.
  4. Ensure that equipment is properly set up and positioned.
  5. Ensure that a signaler is assigned, if required, and identified to the equipment operator.
  6. Direct the lifting operation to ensure that it is done safely and efficiently.
  7. Stop the job when any potentially unsafe condition is recognized.
  8. Direct emergency stabilization operations if an accident or injury occurs.

---

## 3.6 TRAINING

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Specialized training shall be conducted for personnel involved in performing preengineered production lifts. This training shall be periodically reviewed and approved by the responsible operating and oversight organizations (safety, quality assurance, etc.).

### 3.6.1 Equipment Operation

- a. Personnel shall be trained and qualified on the specific types of equipment required.
- b. The equipment operation training shall include:
  1. A demonstration by the individual of operational competence with the equipment.
  2. A demonstration of appropriate safe operating practices.
  3. Documented evidence of the individual's knowledge of safety-related information.

- c. Equipment-operation training shall be repeated for personnel whenever a new or different type of equipment is introduced into the procedure.

### 3.6.2 Procedure

- a. Personnel shall be trained and qualified in the proper execution of each specific procedure.
- b. The procedure training shall include:
  1. A demonstration by the individual of operational competence in performance of the procedure.
  2. Documented evidence of the individual's knowledge of the steps and requirements of the procedure.
- c. Training on a procedure shall be repeated periodically or when a modification to the procedure results in a significant change in the operation.

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# CHAPTER 4

## LIFTING PERSONNEL

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This chapter describes requirements for lifting personnel.

4.1	GENERAL .....	4-1
4.2	MOBILE CRANES .....	4-3
4.3	OVERHEAD CRANES .....	4-4
4.4	PERSONNEL PLATFORM .....	4-5

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## 4.1 GENERAL

a. This chapter specifies the operation, design, testing, and inspection requirements for the use of personnel lift platforms or baskets suspended from mobile or overhead cranes. This chapter implements the requirements of ASME B30.5, "Mobile Cranes."

b. The manager specifically responsible for the overall work function to be performed shall determine that the erection, use, and dismantling of conventional means of reaching the work site (i.e., scaffold, ladder, stairway, aerial lift, or elevating work platform) would be more hazardous or is not possible because of structural design or worksite conditions.

c. For each personnel lifting procedure, the manager responsible for the task shall authorize the use of a crane-suspended work platform and attest to the need for the operation through a written justification attesting to that need. A statement describing the operation and its time frame shall be included. The statement, after being approved by the authorizer, shall be retained at the job site.

d. These special procedures shall be followed when lifting personnel:

1. The crane shall be inspected daily prior to lifting personnel, in accordance with the requirements for frequent inspections for the type of equipment being used.

2. The lifting and supporting shall be made under controlled conditions and under the direction of a designated leader. A qualified signaler shall be appointed.

3. Prior to use each working shift, the personnel lift platform and rigging shall be inspected.

4. At each new job site (and at least annually) prior to hoisting personnel, the personnel platform, rigging, and hook block shall be proof-tested by a qualified inspector to twice the personnel platform's rated capacity by holding it suspended for 5 min with the test load suitably distributed on the personnel platform. After proof-testing, any deficiencies revealed by inspection, or by the proof test, shall be corrected and another proof-test conducted. Any

modification to the personnel platform or rigging shall require retesting.

5. Prior to lifting personnel and after the proof test, the qualified operator and signaler shall conduct a trial lift with the personnel platform loaded to at least the maximum anticipated load. The trial lift shall be made from ground level (or any other location where employees will enter the platform) to each location at which the platform is to be hoisted and positioned. The designated leader and the operator shall determine that:

- i. Crane (mobile) footing is adequate.
- ii. System controls and safety devices are activated and functioning properly.
- iii. No interferences exist.
- iv. Configurations necessary to reach work locations will allow the crane to remain under 50 percent of rated capacity.

NOTE: Materials and tools to be used during the actual lift, if secured to prevent displacement, can be in the platform for the test lift.

NOTE: A single trial lift may be performed for all locations to be reached from a single setup position.

6. The trial lift shall be repeated prior to hoisting employees whenever:

- i. The crane (mobile) travels or is moved and set up in a new location or returned to a previously used location.
- ii. The lift route is changed, unless the operator determines that the safety of the hoisted personnel is not affected.

7. A visual inspection of the crane, rigging, and personnel platform shall be conducted by a qualified inspector immediately after the trial lift, prior to lifting personnel. Any defects found

that create a safety hazard shall be corrected prior to hoisting personnel.

8. After the trial lift and just before hoisting personnel, the platform shall be lifted a few inches and inspected to ensure that it is secure and properly balanced. Personnel shall not be hoisted unless the following conditions exist:

- i. Hoist ropes are free of kinks.
- ii. Multiple-part lines are not twisted around each other.
- iii. The primary attachment is centered over the platform.
- iv. Ropes are properly seated on drums and sheaves.

9. Prior to the trial lift, a meeting shall be held with the designated leader, qualified operator, signaler, persons to be lifted, and the person responsible for overall worksite safety to plan and review procedures to be followed. Procedures for entering and leaving the personnel platform or other device and the points at which persons will enter and leave the device shall be reviewed.

10. Communications between the crane operator, signaler, and persons being lifted shall be maintained throughout the lift.

11. The employees being hoisted, moved, or positioned shall remain in continuous sight of, and in direct communication with, the operator or signaler. In situations where direct visual contact with the operator is not possible and the use of a signaler would create a hazard for that person, direct communication alone (such as a two-way radio) may be used.

12. Tag lines shall be used unless their use creates an unsafe condition.

13. The crane shall be operated so that lowering will be power-controlled (no free-fall).

14. When welding is done by personnel from the platform or basket, the electrode holders shall be protected from contact with metal components of the personnel platform or basket.

15. Employees working from a platform shall wear body belts/harnesses with lanyards attached to the lower load block or overhaul ball, or to a structural member within the platform that is capable of supporting a fall impact. When working above water, the requirements of 29 CFR 1926.106 (Occupational Safety and Health Regulations for Construction) shall also apply.

16. The operator shall remain at the controls when the personnel platform is occupied.

17. Movement of the personnel platform shall be done in a slow, controlled, cautious manner with no sudden movements of it or the crane. The lifting or lowering speed shall not exceed 100 ft/min (30 m/min).

18. The total weight of the lifted load (including personnel) shall not exceed 50 percent of the crane rating under the planned conditions of use.

19. Suspended personnel platforms shall be used only for personnel, their tools, and sufficient materials to do their work. They shall not be used for transporting bulk materials.

20. Personnel shall keep all parts of their bodies inside the suspended personnel platform during raising, lowering, and positioning to avoid pinch points. Personnel shall not stand on or work from the top rail, midrail, or toeboard of the suspended personnel platform.

21. If the personnel platform cannot be landed, it should be tied to the structure before personnel get off or on.

22. Personnel platforms should not be used in winds greater than 15 mph (25 km/h), electric storms, snow, ice, sleet, or other adverse weather conditions that could affect the safety of personnel.

23. After the personnel platform is positioned, all brakes and locks on the lift crane shall be set before personnel perform any work.

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## 4.2 MOBILE CRANES

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Mobile cranes are designed and intended for handling materials, not personnel. In addition to the general requirements in Section 4.1, “General,” the following requirements shall be met when lifting personnel with a mobile crane:

a. Personnel are permitted to ride only in one of the following:

1. A personnel platform that is supported from the crane's hook which meets the requirements of Section 4.4, “Personnel Platform.”

2. A personnel basket attached directly to the boom which is approved by the crane manufacturer.

b. Cranes and derricks with variable-angle booms shall be equipped with a boom-angle indicator that is readily visible to the operator.

c. Cranes with telescoping booms shall be equipped with a device to indicate clearly to

the operator, at all times, the boom's extended length, or an accurate determination of the load radius to be used during the lift shall be made prior to hoisting personnel.

d. A positive-acting device shall be used that prevents contact between the load block or overhaul ball and the boom tip (anti-two-blocking device), or a system shall be used that deactivates the hoisting action before damage occurs in the event of a two-blocking situation (two-block damage-prevention feature).

e. The crane shall be uniformly level within 1 percent of level grade and located on firm footing.

f. Cranes shall not travel while personnel are on a personnel platform or in the basket.

g. Cranes with outriggers shall have the outriggers fully extended and blocked.

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## 4.3 OVERHEAD CRANES

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Overhead cranes are designed and intended for handling materials, not personnel. In addition to the general requirements in Section 4.1, the following requirements shall be met when lifting personnel with an overhead crane.

a. Personnel are permitted to ride only in a personnel platform that is supported from the

crane's hook which meets the requirements of Section 4.4.

b. A hoist-limit switch/device shall be provided in the hoisting direction to stop the hoisting motion to prevent two-blocking.

## 4.4 PERSONNEL PLATFORM

Use only personnel platforms that are specifically designed and constructed for the purpose of suspending personnel according to the following:

- a. The personnel platform shall be designed by a qualified person competent in structural design. All welding of the platform shall be performed by a certified welder familiar with the weld grades, types, and material specified in the design.
- b. The personnel platform shall be limited to carrying six persons.
- c. The personnel platform and rigging shall be capable of supporting, without failure, at least five times the maximum intended load.
- d. The personnel platform shall bear a plate specifying its empty weight and the maximum number of persons and weight for which it is rated.
- e. The personnel platform shall have perimeter protection consisting of a top rail approximately 45 in. (115 cm) high, a toeboard at least 4 in. (10 cm) high, and a midrail approximately halfway between the top rail and the toeboard.
- f. A grab rail shall be provided inside the personnel platform to minimize hand exposure.
- g. The sides of the platform shall be enclosed from the toeboard to the midrail with solid construction or expanded metal having openings no greater than ½ in. (1.27 cm).
- h. If access doors are installed, they shall open only to the interior of the personnel platform. Access doors shall be equipped with
  - i. a device to prevent them from opening unintentionally.
  - j. The personnel platform shall have overhead protection when there is an overhead hazard.
  - k. Sufficient headroom shall be provided to allow employees to stand upright in the platform.
  - l. Rough edges exposed to contact by employees shall be surfaced (ground smooth) to prevent injury.
  - m. The personnel platform shall be easily identifiable by high-visibility color or marking.
  - n. All welding procedures and welding operator qualifications shall be in accordance with ANSI/AWS D1.1 when welding is to be performed on load-sustaining members. Where special steels or other materials are used, the manufacturer shall provide welding procedures. Welds shall be inspected by a qualified inspector.
  - o. When being supported by a crane, the platform shall be attached to the hoist rope by a hook of a type that can be closed and locked, eliminating the hook throat opening. Alternatively, an alloy-steel anchor shackle with a bolt, nut, and retaining pin may be used.
  - p. All eyes in wire-rope slings shall be fabricated with thimbles. No rigging accessories for attaching the personnel platform to hoist lines shall be used for any other purpose when not hoisting personnel.
  - q. The suspension system shall minimize inclination of the personnel platform due to the movement of personnel on it.

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# CHAPTER 5

## HOSTILE ENVIRONMENTS

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This chapter describes provisions for hoisting and rigging operations in hostile work environments.

5.1	GENERAL .....	5-1
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5.2.1	Marking and Posting .....	5-2
5.2.2	Inspection and Testing .....	5-2
Exhibit I	Hostile Environment Plan .....	5-4

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## 5.1 GENERAL

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a. This chapter contains the special provisions for hoisting and rigging operations and equipment in hostile environments where standard operating, maintenance, inspection, or test procedures cannot be followed as a result of radiation or radioactive contamination, toxic/hazardous chemicals or gases, or temperature extremes.

b. Hoisting and rigging activities can usually be accomplished where the environment will allow normal operations with access for hands-on equipment contact. In those situations, operations, maintenance, inspections, and tests shall be done in accordance with regular provisions of this standard.

c. Hoisting and rigging equipment or operations shall be reviewed by a designated person to determine compliance with the requirements of this standard. If it is determined to be impossible or unreasonable for the requirements of this standard to be met as a result of hostile environmental conditions, a hostile environment plan shall be prepared to document alternative compliance methods and procedures.

d. All hoisting and rigging operations shall be consistent with DOE's policy of as-low-as-reasonably achievable (ALARA) radiation exposure.

e. Safety of personnel shall remain the first priority.

## 5.2 HOSTILE ENVIRONMENT PLAN

a. A hostile environment plan shall be prepared by a designated person and shall cover operations, equipment, inspection, testing, and maintenance. See Exhibit I, Hostile Environment Plan, at the end of this chapter.

b. At a minimum, the plan shall be reviewed and approved by responsible management at the facility where the crane, hoist, or other equipment is located and by responsible management of an overview organization such as safety or quality assurance. While the site-specific organizational structure will determine other required reviews and approvals, approval by the following is recommended:

1. Responsible operations manager.
2. Equipment custodian.
3. Cognizant engineer.

c. The plan shall address only those actions or features that require deviation from the requirements of this standard due to a hostile environment. At a minimum, it shall contain the following information:

1. The specific requirements that cannot be met.
2. The difference between the requirement and actual conditions.
3. Justification for not meeting this standard's requirements.
4. A statement of actions or features to be used to compensate for the differences.
5. Specific maintenance, inspections, and tests to be performed whenever access is possible.
6. Replacement or retirement criteria for equipment that is designed to operate with little or no maintenance.

d. Detailed operation, inspection, testing, and maintenance procedures that state specific requirements and acceptance criteria shall be prepared, based on the hostile environment plan.

e. The responsible manager shall ensure that the approved hostile environment plan is distributed as follows:

1. DOE Field Office or equivalent (for information).
2. Equipment operators, maintenance organizations, and other organizations/ personnel affected by the plan.
3. Equipment history file.

f. Hostile environment plans in the equipment history file shall be readily available to appointed personnel.

### 5.2.1 Marking and Posting

Equipment the use of which is required by a hostile environment plan shall be posted with the following information: "Special Maintenance and Operating Instructions Required—see Hostile Environment Plan."

### 5.2.2 Inspection and Testing

a. Handling fixtures and rigging accessories shall be qualified in accordance with Chapters 11, 12, and 14 ("Wire Rope and Slings," "Rigging Accessories," and "Below-the-Hook Lifting Devices," respectively) of this standard prior to being exposed to the hostile environment.

b. Nylon (rope or webbing) slings should not be used in a radiation area unless absolutely necessary. When it is necessary to use a nylon or polyester sling in a radiation area, the responsible manager shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

EXHIBIT I

HOSTILE ENVIRONMENT PLAN

Building: \_\_\_\_\_ Location: \_\_\_\_\_

Type crane/hoist: \_\_\_\_\_

(e.g., overhead top-running bridge and trolley, top-running bridge with underhung hoist, jib crane, monorail hoist, overhead hoist)

Capacity (main): \_\_\_\_\_ (Auxiliary): \_\_\_\_\_

Power method: \_\_\_\_\_

Manufacturer: \_\_\_\_\_

1.a. H&R standard requirement that will not be met

Section number: \_\_\_\_\_  
(copy the applicable section)

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

1.b. Difference between standard requirement and what is to be allowed by this plan:

\_\_\_\_\_  
\_\_\_\_\_

1.c. Justification for not meeting the standard requirement:

\_\_\_\_\_  
\_\_\_\_\_

1.d. Actions or features to compensate for differences:

\_\_\_\_\_  
\_\_\_\_\_

Include information regarding replacement or retirement criteria for this equipment. Include information regarding any special design, maintenance, or test considerations that apply to this equipment.

\_\_\_\_\_  
\_\_\_\_\_

APPROVAL (signature/date)

\*Facility Manager: \_\_\_\_\_ Date: \_\_\_\_\_

\*Manager, Oversight Organization: \_\_\_\_\_ Date: \_\_\_\_\_

Other: \_\_\_\_\_ Date: \_\_\_\_\_

\_\_\_\_\_ Date: \_\_\_\_\_

\_\_\_\_\_ Date: \_\_\_\_\_

\*means approval is mandatory

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# CHAPTER 6

## PERSONNEL QUALIFICATION AND TRAINING

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This chapter describes personnel qualification and training. Only qualified personnel shall operate the equipment covered in this standard.

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## 6.1 GENERAL

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a. This chapter delineates the requirements for the qualification and training of operators, riggers, inspectors, and trainers.

b. Personnel who are designated to operate equipment or perform work covered by this standard shall be qualified and trained to the level of proficiency consistent with assigned tasks.

## 6.2 QUALIFICATION

### 6.2.1 General

Only qualified personnel or trainees, under the direct supervision of qualified personnel, who meet the following requirements shall be allowed to rig, operate, or inspect cranes, hoists, or powered forklift trucks:

- a. Be at least 18 years old.
- b. Understand spoken and written English or a language generally in use at the work location.

### 6.2.2 Operators of Cab-Operated and Pulpit-Operated Cranes

a. Operators and operator trainees shall meet the following physical qualifications.

1. Have vision of at least 20/30 Snellen in one eye and 20/50 in the other, with or without corrective lenses. Operators whose jobs do not require binocular vision (operation of cranes with television cameras or periscope optics) shall have distant visual acuity of 20/30 in one eye and no specific visual requirement for the other eye.
2. Be able to distinguish colors, regardless of position, if color differentiation is required for operation.
3. Have adequate hearing, with or without a hearing aid, for a specific operation.
4. Have physical strength, coordination, and sufficient reaction speed to meet the demands of equipment operation.
5. Show no evidence of physical defects or of emotional instability that could be a hazard to themselves or others, or which, in the opinion of the examiner, could interfere with their safe performance; such evidence may be sufficient cause for disqualification. In these cases, medical judgments and tests may be required.
6. Show no evidence of being subject to seizures or to loss of physical control; such evidence shall be sufficient reason for disqualification. Medical examinations may be required to determine these conditions.

7. Have normal depth perception, field of vision, manual dexterity, coordination, and no tendencies to dizziness or similar potentially hazardous characteristics.

8. Have no detectable or known disease or physical restriction that would render them incapable of safely operating equipment or carrying out rigging duties. Where any deficiency of an upper or lower extremity exists, the acceptability of a candidate shall be the decision of the supervisor, after consulting with the designated physician.

b. Operators shall be required by the employer to pass a practical operating skill evaluation. Qualification shall be limited to the type of equipment for which the operator is being evaluated. The actual or simulated operation shall enable trainees to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

### 6.2.3 Operators of Mobile Cranes

a. Operators and operator trainees shall meet the following physical qualifications.

1. Have vision of at least 20/30 Snellen in one eye and 20/50 in the other, with or without corrective lenses.
2. Be able to distinguish colors, regardless of position, if color differentiation is required for operation.
3. Have adequate hearing, with or without a hearing aid, for a specific operation.
4. Have physical strength, coordination, and sufficient reaction speed to meet the demands of equipment operation.
5. Show no evidence of physical defects or of emotional instability that could be a hazard to themselves or others, or which, in the opinion of the examiner, could interfere with their safe performance; such evidence may be sufficient cause for disqualification. In these cases, medical judgments and tests may be required.
6. Show no evidence of being subject to seizures or to loss of physical control; such evidence shall be sufficient reason for

disqualification. Medical examinations may be required to determine these conditions.

7. Have normal depth perception, field of vision, manual dexterity, coordination, and no tendencies to dizziness or similar potentially hazardous characteristics.

8. Have no detectable or known disease or physical restriction that would render them incapable of safely operating equipment or carrying out rigging duties. Where any deficiency of an upper or lower extremity exists, the acceptability of a candidate shall be the decision of the supervisor, after consulting with the designated physician.

9. Shall successfully pass with a negative result, a substance abuse test. The level of testing will be determined by the standard practice for the industry where the crane is employed and this test shall be confirmed by a recognized laboratory service.

10. Operator physical examinations shall be required every three years or more frequently if supervision deems it necessary.

b. Operators shall be required by the employer to satisfactorily pass a written examination covering operational characteristics, controls, and emergency control skills such as response to:

1. Fire.
2. Power line contact.
3. Loss of stability.
4. Control malfunction.

5. As well as characteristic and performance questions appropriated to the crane type for which qualifications is sought.

c. Operators shall demonstrate their ability to read, write, comprehend and exhibit arithmetic skills and load/capacity chart usage, in the language of the crane manufacturer's operation and maintenance instruction materials.

d. Operators shall satisfactorily complete a combination written and verbal test on load/chart usage that covers a selection of the configurations (the crane may be equipped to handle) for the type crane for which qualification is being sought.

e. The operator shall complete a practical operating skill evaluation test (actual or simulated), demonstrating proficiency and basic knowledge in handling the specific type crane for which the operator is being evaluated, including:

1. Pre-start and post-start inspection.
2. Maneuvering skills.
3. Shutdown.
4. Securing the crane.

f. Qualification shall be limited to the type of equipment for which the operator is being evaluated.

g. Trainee qualification requirements shall include but not limited to the following:

1. Satisfactory completing of a written examination covering safety, operational characteristics and limitations, and controls of the type crane for which they are being qualified.

2. Demonstrate their ability to read, write, comprehend, and exhibit arithmetic skills and load/capacity chart usage, in the language of the crane manufacturer's operations and maintenance instruction materials.

3. Satisfactory completion of a combination written and verbal test on load/capacity chart usage covering various crane configurations.

## 6.2.4 Operators of Floor-Operated Cranes

a. Physical qualifications shall be based on specific job requirements.

b. Operators shall be required by their employer to pass a practical operating skill evaluation. Qualification shall be limited to the type of equipment for which the operator is being evaluated.

c. The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

## 6.2.5 Operators of Forklift Trucks

- a. Physical qualifications shall be based on specific job requirements.
- b. Operators shall be required by the employer to pass a practical operating skill evaluation. Qualification shall be limited to the type of forklift for which the operator is being evaluated.
- c. The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

## 6.2.6 Riggers

Riggers shall be required to pass a practical rigging skill evaluation that requires the use of rigging equipment in safe configurations. The actual or simulated operation shall enable personnel to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

## 6.2.7 Person-In-Charge (PIC)

The PIC shall have the necessary knowledge and experience of the specific type of equipment and the hazards of critical lifts to direct the safe completion of the operation. The PIC shall understand the rules and procedures implemented at the site to ensure that the following are completed:

- a. Necessary administrative requirements.
- b. Personnel assignments and responsibilities.
- c. Selection of proper equipment/tools.
- d. Recognition and control of hazardous or unsafe conditions.
- e. Job efficiency and safety.
- f. Critical-lift documentation.

In addition, the PIC shall

- a. Direct operations in the case of an accident.
- b. Exercise authority to start and stop work activities.

## 6.2.8 Designated Leader

The designated leader shall have sufficient knowledge and experience to accomplish the following responsibilities:

- a. Ensure that personnel involved understand how the lift is to be made.
- b. Ensure that the weight of the load is determined and that proper equipment and accessories are selected.
- c. Survey the lift site for hazardous or unsafe conditions.
- d. Ensure that equipment is properly set up and positioned.
- e. Ensure that a signaler is assigned, if required, and is identified to the operator.
- f. Direct the lifting operation to ensure that the job is done safely and efficiently.
- g. Stop the job when any potentially unsafe condition is recognized.
- h. Direct operations if an accident or injury occurs.

## 6.2.9 Inspectors

Qualified inspectors shall have the necessary knowledge and experience to properly inspect hoisting and rigging equipment.

## 6.2.10 Instructors

Instructors responsible for developing or presenting hoisting and rigging training programs shall meet the qualification standards specified by the responsible training organization.

## 6.2.11 First-Line Supervisors

The first-line supervisor of hoisting and rigging operations should be knowledgeable of the specific types of hoisting and rigging operations under their supervision and their operational hazards. The supervisor shall be familiar with applicable rules and procedures implemented at the site to ensure that hoisting and rigging work under their control is done efficiently and safely, with safety as top priority. Supervisors should ensure that employees fully understand the importance of safety and that they recognize their

own authority and responsibility to stop work when safety is questionable.

### 6.2.12 Maintenance Personnel

a. Employees who perform maintenance activities on equipment covered by this handbook should have an understanding of the following criteria:

1. The tools to safely accomplish their work.
2. Access to operating instructions to perform adjustments.

3. Parts information furnished by the manufacturer or the responsible maintenance/engineering organization.

4. Manufacturers' recommendations as to points and frequency of lubrication and levels and types of lubricant to be used.

5. Maintenance and repair procedures recommended by the manufacturer or responsible maintenance/engineering organization.

6. Wiring diagrams.

7. Documentation requirements for maintenance and repair.

## 6.3 TRAINING

### 6.3.1 General

a. Organizations that employ personnel who operate, rig, or inspect equipment covered in this standard shall provide training programs, including a means of evaluation, to ensure that the personnel are competent to perform the operations.

b. Training programs for operators should address two levels of required performance.

1. Persons who may operate pendant-controlled cranes, manual hoists, and forklifts as an incidental part of their normal work assignment.

2. Persons whose principal assignment is the performance of hoisting and rigging work.

c. The training organization shall use training methods best suited for the students and the subject material. This may include, but is not limited to, computer-aided training, classroom training, simulated field training, on-the-job training (OJT), and training by equipment manufacturer or commercial training companies.

d. Score standards shall be set for each examination by the training organization. The minimum passing score will depend on the subject, testing technique, and test difficulty. Management shall determine the course of action for persons receiving negative evaluations.

### 6.3.2 Operators of Cab-Operated, Pulpit-Operated, and Floor-Operated Cranes

a. Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate cab-operated, pulpit-operated, and floor-operated cranes.

b. The initial training of operators shall include:

1. Applicant training on equipment for which qualification is sought, under the direction of a qualified operator who is designated by management to instruct in the operation of hoisting equipment.

2. Instructor review of the applicant's knowledge, including results of written and oral evaluation, and witnessing a demonstration of the operator's skills.

c. Operators should be able to demonstrate a knowledge of equipment operating characteristics, capabilities, limitations, effects of variables, safety features, and operating procedures. The following checklist contains basic factors with which an operator should be familiar. This checklist must be tailored to suit actual conditions.

1. Operating characteristics.
2. Environmental hazards—weather.
3. Electrical hazards.
4. Traveling with load.
5. Traveling without load.
6. Lifting personnel.
7. Inspections/tests.
8. Load weight estimation.
9. Emergency procedures.
10. Rigging.
11. Lessons learned.
12. Hand signals.
13. Load dynamics.
14. Applicable standards and regulations.
15. Critical lifts.
16. Safety features of equipment.
17. Terminology and definitions.
18. Ropes and reeving.
19. Two-blocking.
20. Records and documents.
21. Limit switches, warning signals.

22. Operating practices.
23. Fire protection.
24. Crane components.
25. Access and egress.
26. Warning devices.

### 6.3.3 Mobile Crane Operators

a. Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate mobile cranes.

b. Operators shall meet the criteria specified in paragraphs 6.3.2.b and c, and they should also be able to demonstrate an understanding of the following:

1. Stability.
2. Load charts.
3. Crane setup.
4. Refueling.
5. Lifting operations involving multiple cranes.
6. Assembly and disassembly.
7. Outriggers.
8. Operator aids.

### 6.3.4 Forklift Truck Operators

a. Only qualified and authorized operators or operator trainees under the direct supervision of a qualified operator shall be permitted to operate powered forklift trucks.

b. The initial training of operators shall include:

1. Applicant training on equipment for which qualification is sought, under the direction of a qualified operator who is designated by management to instruct in the operation of hoisting equipment.

2. Instructor review of the applicant's knowledge, including results of written and oral evaluation, and witnessing a demonstration of the operator's skills.

c. The following checklist contains basic factors with which a forklift truck operator should be familiar. This checklist must be tailored to suit actual conditions.

1. Stability (equipment).
2. Operating characteristics (equipment).
3. Capacity chart (read).
4. Environmental hazards—weather.
5. Hazardous areas or locations.
6. Traveling with load.
7. Traveling without load.
8. Lifting personnel.
9. Inspections and tests.
10. Load weight estimation.
11. Emergency procedures.
12. Lessons learned.
13. Refueling/recharging.
14. Hand signals.
15. Maintenance.
16. Attachments.
17. Load dynamics.
18. Applicable standards and regulations.
19. Critical lifts.
20. Safety features of equipment.
21. Modifications.
22. Adequate illumination.
23. Terminology and definitions.

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>24. Records and documents.</li> <li>25. Operating practices.</li> <li>26. Fire protection.</li> <li>27. Components.</li> </ul> | <ul style="list-style-type: none"> <li>13. Lifting operations involving multiple cranes.</li> <li>14. Maintenance/storage of slings and rigging components.</li> <li>15. Assembly and disassembly.</li> <li>16. Load dynamics.</li> <li>17. Applicable standards and regulations.</li> <li>18. Critical lifts.</li> <li>19. Safety features of equipment.</li> <li>20. Terminology and definitions.</li> <li>21. Ropes and reeving.</li> <li>22. Records and documentation.</li> <li>23. Adjustments and repairs.</li> <li>24. Rigging/operating practices.</li> <li>25. Sling loading.</li> <li>26. Load-indicating devices.</li> <li>27. Personal protective equipment.</li> <li>28. Below-the-hook lifting devices.</li> <li>29. Rigging or hitch configuration.</li> <li>30. D/d ratio.</li> <li>31. Sling types and application.</li> </ul> |
|---|--|

### 6.3.5 Riggers

a. Training programs for riggers should address two levels of required performance:

- 1. Persons who may perform rigging functions as an incidental part of their normal work assignment.
- 2. Persons whose principal assignment is the performance of rigging work.

b. Only qualified and authorized riggers or rigger trainees under the direct supervision of a qualified rigger shall be permitted to perform rigging functions.

c. Initial training of riggers shall include the instructor's review of the applicant's knowledge, including results of written or oral evaluation, and witnessing a demonstration of the operator's skills. The following checklist contains basic factors with which a rigger should be familiar. This checklist must be tailored to suit actual conditions.

- 1. Stability (equipment).
- 2. Operating characteristics of equipment.
- 3. Environmental hazards—weather.
- 4. Electrical hazards.
- 5. Traveling with load/load control.
- 6. Lifting personnel.
- 7. Inspection/tests.
- 8. Load weight estimation.
- 9. Emergency procedures.
- 10. Rigging equipment selection.
- 11. Lessons learned.
- 12. Hand signals.

### 6.3.6 Inspectors

a. Employees who perform required, documented inspections of equipment covered by this standard shall receive inspector training.

b. Inspector training shall include basic inspection techniques and acceptance/rejection criteria as specified in this standard and other applicable sources. See Chapter 3, "Preengineered Production Lifts."

c. The following equipment categories for general inspection are examples that should be considered:

- 1. Overhead, gantry, and polar cranes.

2. Monorail, jib, and other hoists.
3. Mobile cranes (hydraulic and lattice boom).
4. Forklift trucks.
5. Wire-rope, chain, and synthetic-web slings.
6. Rigging accessories.

### 6.3.7 Instructors

a. Instructors designated by management to be responsible for developing or presenting hoisting and rigging training programs shall develop technical competence by becoming familiar with the requirements of this standard and by satisfactorily completing documented training or technical experience in the hoisting and rigging discipline.

b. Instructors should attend recognized training courses, workshops, or seminars in order to remain current on industry practices and changes in applicable codes and standards.

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## 6.4 REQUALIFICATION

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a. Operator, rigger, and inspector qualification is for a period not to exceed 3 years, unless the qualification is revoked sooner by the employee's manager.

b. The program for requalification shall include:

1. Completion of a written or oral evaluation relevant to the type of equipment used or participation in a refresher training program.

2. A performance evaluation.

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## **6.5 RECORDS**

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A record of training and skill evaluations shall be kept on file and shall be readily available

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# CHAPTER 7

## OVERHEAD AND GANTRY CRANES

This chapter specifies operation, inspection, maintenance, and testing requirements for the use of overhead and gantry cranes and implements the requirements of ASME B30.2 [“Overhead and Gantry Cranes (Top-Running Bridge, Single or Multiple Girder, Top-Running Trolley Hoist)”], B30.11 (“Monorail Systems and Underhung Cranes”), and B30.17 [“Overhead and Gantry Cranes (Top-Running Bridge, Single Girder, Underhung Hoist)”]. Only equipment built to the appropriate design standards shall be used in DOE installations.

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## 7.1 GENERAL

Overhead and gantry cranes include top-running single- or multiple-girder bridge with top-running trolley hoists (Figure 7-1), top-running single-girder bridge with underhung trolley hoists (Figure 7-2), and monorails/underhung cranes (Figure 7-3).

### 7.1.1 Operator Training/Qualification

Operators of overhead cranes shall be trained and qualified as required in Chapter 6, "Personnel Qualification and Training."

### 7.1.2 Rated-Load Marking

The rated capacity shall be marked on each side of the crane. If the crane has more than one hoisting unit, each hoist shall have its rated capacity marked on it or on its load block. Markings on the bridge, trolley, and load block shall be legible from the ground or floor.

### 7.1.3 Modification

Cranes may be modified or rerated provided that the modifications or supporting structures are analyzed thoroughly by a qualified engineer or by a manufacturer of cranes. Modifications and reratings must be approved by the cognizant safety organization. A rerated crane, or one whose load-supporting components have been modified, shall be tested in accordance with Section 7.3, "Testing." The new rated capacity shall be displayed in accordance with Section 7.1.2, "Rated-Load Marking."

### 7.1.4 Egress

On cab-operated cranes, there shall be at least two means of egress from the crane, remote from each other, and arranged to permit departure under emergency conditions.

### 7.1.5 Hoist Brakes

a. Each independent hoisting unit shall be equipped with at least one holding brake applied directly to the motor shaft or some part of the gear train.

b. Each independent hoisting unit (except worm-gear hoists, the angle of whose worm prevents the load from accelerating as it is being lowered) shall be equipped with a controlled-braking means in addition to the holding brake to control speed of lowering.

c. Holding brakes on hoists shall be applied automatically when power is removed.

### 7.1.6 Power Shutoff

a. The power supply for the runway conductors shall be controlled by a switch or circuit-breaker located on a fixed structure, accessible from the floor, and capable of being locked in the OPEN position.

b. On cab-operated cranes, an enclosed switch or circuit-breaker (with provisions for locking in the OPEN position) shall be provided in the leads from the runway conductors. A means of opening this device shall be located within reach of the operator when the operator is in the operating position. When the operator opens this switch or circuit-breaker, the holding brakes should set.

c. On floor, remote, or pulpit-operated cranes, an enclosed disconnect device shall be provided in the leads from the runway conductors. This device shall be mounted on the bridge or footwalk near the runway collectors. There shall be provisions for locking the device in the OPEN position unless the crane is the only load on a lockable switch or circuit-breaker that is accessible from the floor. One of the following types of floor, remote, and pulpit-operated disconnects shall be provided.

1. A nonconductive rope attached to the main disconnect device on a floor-operated crane. If this is selected, the rope shall be suspended adjacent to the operating ropes if manual controllers are used, or near the pendant push-button station if magnetic controls are used.

2. An under-voltage trip for a main circuit-breaker, operated by an emergency stop button in the pendant push-button station or the pulpit.

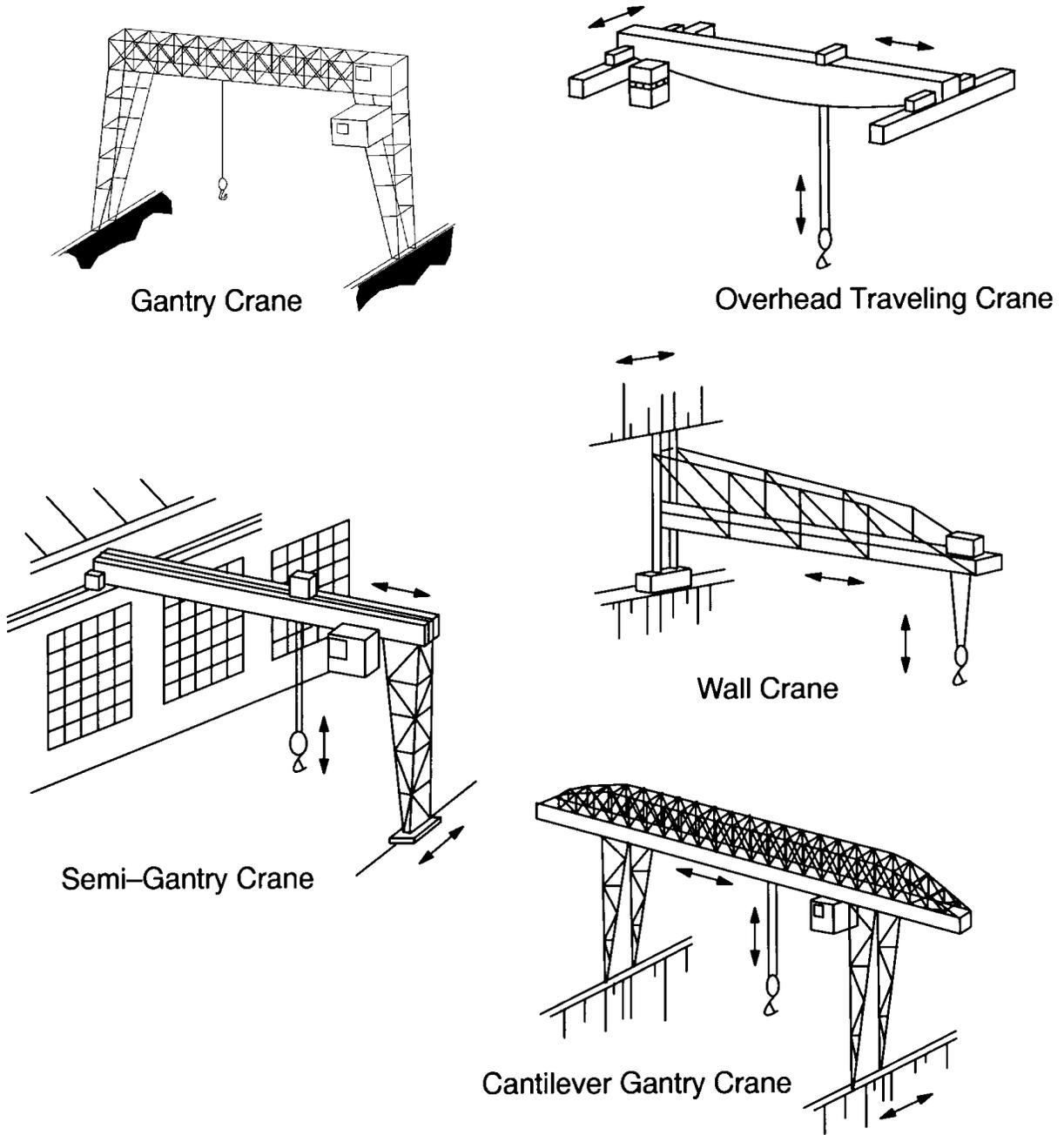
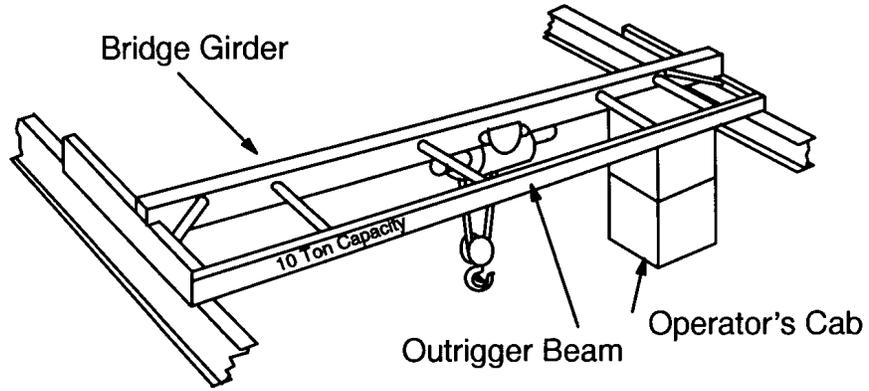


Figure 7-1. Top-running single- or multiple-girder bridge with top-running trolley hoist.



Overhead Cab-Operated Crane

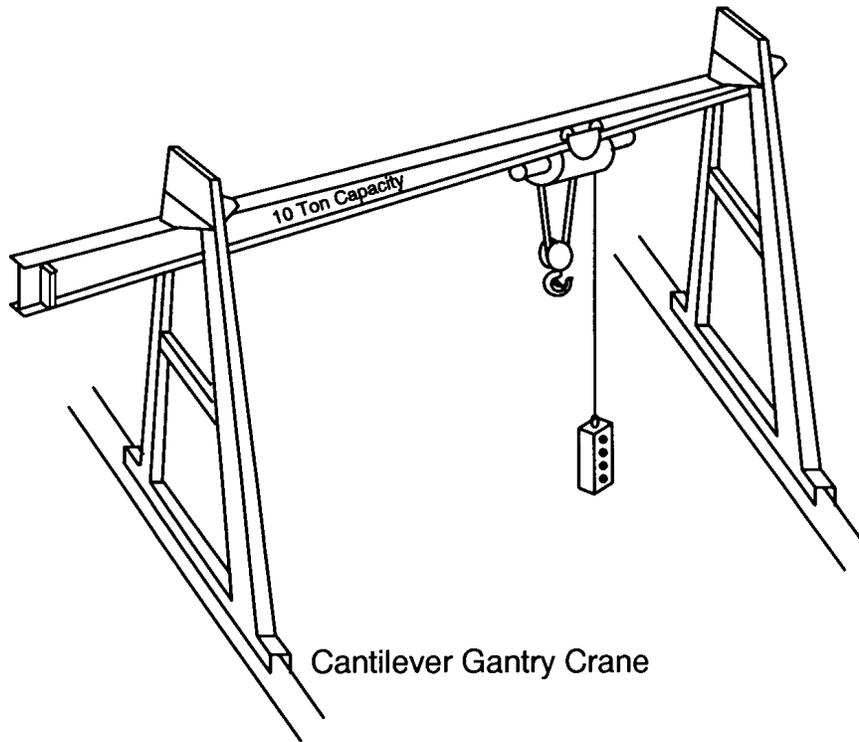


Figure 7-2. Top-running single-girder bridge with underhung trolley hoist.

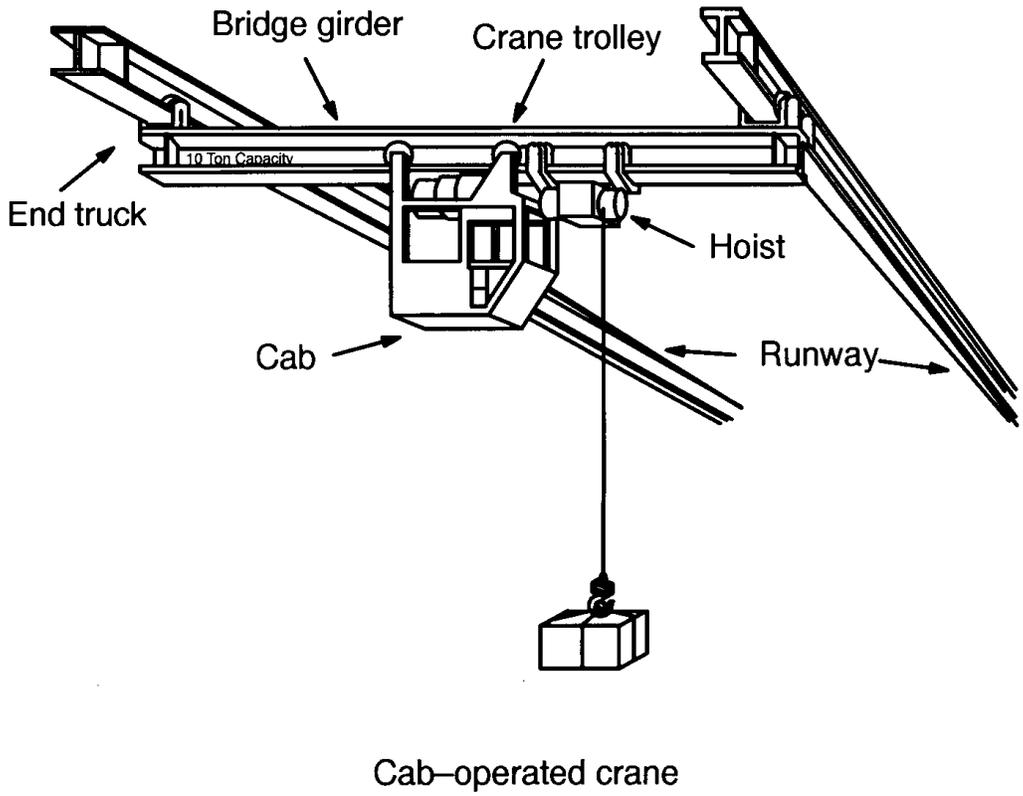
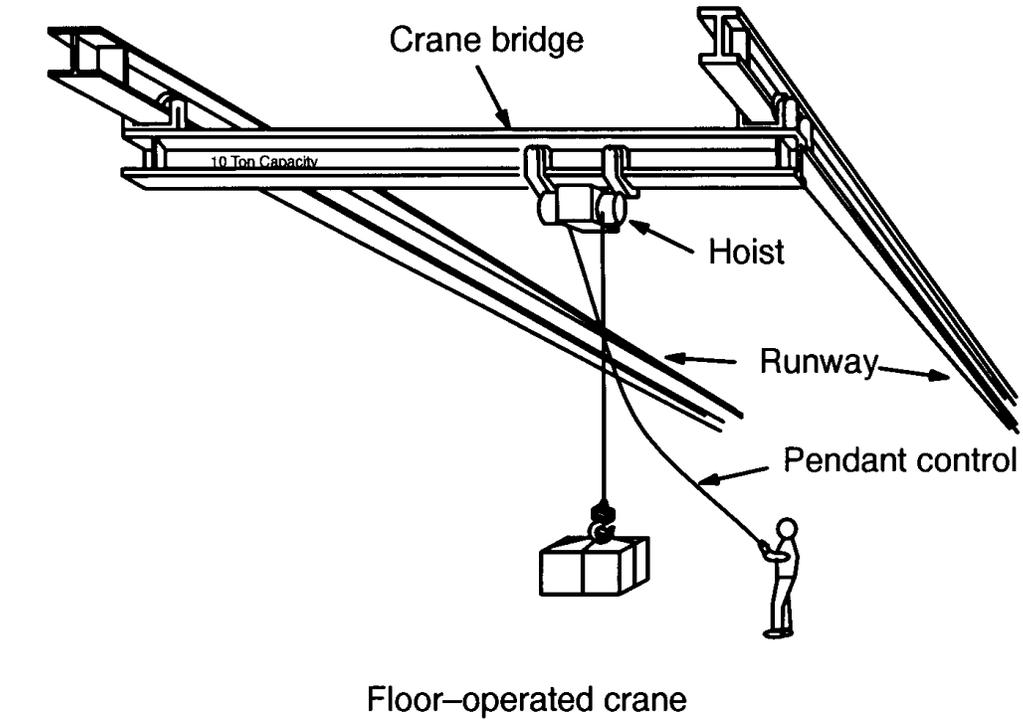


Figure 7-3. Monorails and underhung cranes.

3. A main-line contactor operated by a switch or push button on the pendant push-button station, the remote-control station, or the pulpit.

### **7.1.7 Hoist-Limit Switch**

a. The hoisting motion of all cranes shall have an overtravel-limit switch/device in the hoisting direction to stop the hoisting motion.

b. Lower-travel limit switches/devices should be provided for all hoists where the load block enters pits or hatchways in the floor.

### **7.1.8 Load Limits**

The crane shall not be loaded beyond its rated capacity except for test purposes, as described in Section 7.3.

### **7.1.9 Maintenance History**

The maintenance history of the crane shall be retained throughout its service life.

## 7.2 INSPECTIONS

### 7.2.1 General

a. There shall be no apparent damage, excessive wear, or deformation of any load-bearing part of the equipment. Brakes shall work satisfactorily and load brakes shall be designed to hold any load up to at least 125 percent of the rated stable capacity of the equipment without slipping or overheating. All safety devices, load indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order. Parts found to be defective during any inspection or nondestructive examination shall be replaced or repaired as directed by the responsible line manager or that person's designated representative.

b. Frequency notation as used in dates for frequent and periodic inspections should be defined as follows:

1. Daily--24 hours.
2. Weekly--7 days.
3. Monthly--31 days.
4. Quarterly--92 days.
5. Semi-annually--184 days.
6. Yearly--365 days.

c. Violations of inspection periods may be granted on a case by case basis, provided there is a pre-established site specific policy.

### 7.2.2 Crane Service

Crane service is defined as follows:

- a. Normal service—operating at less than 85 percent of rated load and not more than 10 lift cycles/hr except for isolated instances.
- b. Heavy service—operating at 85 to 100 percent of rated load or in excess of 10 lift cycles/hr as a regular specified procedure.
- c. Severe service—operating at normal or heavy service under abnormal operating conditions (i.e., extreme temperatures, corrosive atmospheres).

### 7.2.3 Initial Inspection

Prior to their initial use, all new, reinstalled, modified, or extensively repaired cranes shall be inspected by a qualified inspector to ensure compliance with applicable provisions of this chapter. Dated and signed inspection reports shall be kept on file and shall be readily available.

### 7.2.4 Daily Preoperational Check

a. Operators or other designated personnel shall visually inspect items such as the following each day or prior to first use if the hoist has not been in regular service (records are not required):

1. Controls and operating mechanisms for proper operation.
2. Hoist upper-limit switch/device for proper operation at the beginning of each shift or prior to use if hoist has not been in regular service.
3. Lines, valves, and other parts of air systems for leakage.
4. Hooks for cracks, deformation and damage from chemicals (see Chapter 13, "Load Hooks," for additional hook requirements).
5. Hoist rope for significant wear, kinking, crushing, birdcaging, and corrosion. The inspection shall be made by running out as much of the rope or chain as is necessary to visually examine those portions that flex over sheaves, sprockets, and the like, and other areas subject to wear or abrasion.
6. Hoist chain for nicks, gouges, distortion, wear, and corrosion.
7. Hook latch, if used, for proper operation.

b. Operators or other designated personnel shall examine deficiencies and determine whether they constitute a hazard and whether a more detailed inspection is required.

## 7.2.5 Monthly Rope, Chain, and Hook Inspection

- a. The operator or other designated person shall visually inspect the following items for damage, wear, or other deficiency that might reduce capacity or adversely effect the safety of the crane:
1. hoist rope or chain
  2. hooks
- b. Lower the hook block to its lowest position and examine for any condition that could result in an appreciable loss of strength.
- c. Hoist rope for significant wear, kinking, crushing, birdcaging, and corrosion.
- d. Hoist chain for nicks, gouges, distortion, wear, and corrosion.
- e. Hooks for cracks, deformation, damage from chemicals, latch engagement (if provided), and evidence of heat damage.
- f. Signed and dated inspection records shall be kept on file and shall be readily available.
- g. Before the crane is returned to service, correct deficiencies that could reduce its capacity or adversely effect its safety.

## 7.2.6 Frequent Inspection

- a. Operators or other designated personnel shall visually inspect the crane at the following intervals (records are not required):
1. Normal service—monthly.
  2. Heavy service—weekly to monthly.
  3. Severe service—daily to weekly.
- b. In addition to the requirements of Section 7.2.4, “Daily Preoperational Check,” these inspections shall include the following:
1. Hoist braking system for proper operation.
  2. Hoist rope or chain reeving for compliance with hoist manufacturer's recommendations.

3. Observations during operation.

- c. Operators or other designated personnel shall examine deficiencies and determine whether a more detailed inspection is required.

## 7.2.7 Periodic Inspection

- a. A qualified inspector shall perform a complete inspection at the following intervals:

1. Normal service—yearly.
2. Heavy service—semiannually.
3. Severe service—quarterly.

- b. The qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard and whether the crane should be removed from service until it is repaired.

- c. Dated and signed inspection records shall be kept on file and shall be readily available.

- d. A sample load test and inspection form is included as Exhibit I, which appears at the end of this chapter. This form is intended to be a sample only and is not intended to be mandatory.

### 7.2.7.1 Cranes

In addition to the requirements of Section 7.2.6, “Frequent Inspections,” periodic inspections shall include the following:

- a. Components for deformation, cracks, or corrosion.
- b. Bolts, rivets, nuts, and pins for being loose or absent.
- c. Sheaves and drums for cracks or wear.
- d. Parts such as pins, bearings, shafts, gears, rollers, locking and clamping devices, bumpers, and stops for wear, cracks, or distortion.
- e. Brake-system parts, linings, pawls, and latches for excessive wear.
- f. Load, wind, and other indicators over their full range for any significant inaccuracies.
- g. Gasoline, diesel, electric, or other power plants for improper performance or noncompliance with other applicable standards.

h. Chain-drive sprockets for excessive wear and chains for excessive stretch.

i. Electrical apparatus for signs of any deterioration of controllers, master switches, contacts, limit switches, and push-button stations (not limited to these items).

j. Hooks for damage from chemicals, deformation, cracks, or having more than 15 percent in excess of normal throat operating, or more than 10 degree twist from the plane of the unbent hook (see Chapter 13 for additional hook requirements).

k. Hook retaining nuts or collars and pins, welds, or riveting used to secure the retaining members for soundness.

l. Nondestructive examination of hooks and of welds, bearings, or other suspect load-bearing parts when required by the inspector.

m. Testing of motion limit devices, which interrupt power or cause a warning to be activated, for proper performance (each motion shall be inched or operated at low speed into the limit device with no load on the crane).

n. Function labels for legibility.

### 7.2.7.2 Wire Rope

a. A qualified inspector shall inspect all ropes at least annually. This inspection shall include examination of the entire length of the rope, without detaching it from the hoist drum. More frequent intervals shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration such as described below resulting in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk.

1. Reduction of rope size below nominal diameter, whether due to loss of core support, internal or external corrosion, or wear of outside wires (see Table 7-1).

**Table 7-1. Maximum allowable rope reductions.**

Rope diameter	Maximum allowable reduction from nominal diameter
Up to 5/16 in. (8 mm)	1/64 in. (0.4 mm)
Over 5/16 in. to 1/2 in. (13 mm)	1/32 in. (0.8 mm)
Over 1/2 in. to 3/4 in. (19 mm)	3/64 in. (1.2 mm)
Over 3/4 in. to 1 1/8 in. (29 mm)	1/16 in. (1.6 mm)
Over 1 1/8 in. to 1 1/2 in. (38 mm)	3/32 in. (2.4 mm)

2. The number and distribution or concentration of broken outside wires.

3. Worn outside wires.

4. Sections of rope that are normally hidden during inspection or maintenance procedures, such as parts passing over sheaves (these are points most subject to deterioration).

5. Corroded or broken wires at end connections.

6. Corroded, cracked, bent, worn, or improperly applied end connections.

7. Kinking, crushing, cutting, or unstranding.

b. All rope on cranes that have been idle for 1 month or more due to shutdown or storage shall be inspected before the crane is returned to service. A dated and signed report of the rope inspection, including results, shall be filed.

c. No precise rules can be given for determining the exact time to replace rope because many variables are involved. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

Conditions such as the following shall be sufficient reason for questioning rope safety and considering replacement:

1. In running ropes, 12 randomly distributed broken wires in one rope lay, or 4 broken wires in one strand in one rope lay.
2. Wear of one-third of the original diameter of outside individual wires.
3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
4. Evidence of heat damage from any cause.
5. Reductions from nominal diameter greater than those listed in Table 7-1.

d. Replacement rope and connections shall have a strength at least as great as the original rope and connections furnished by the crane manufacturer. Any deviation from the original size, grade, or construction shall be specified by a rope manufacturer, the crane manufacturer, or a qualified person.

e. Never use discarded rope for slings.

### 7.2.7.3 Chain (Welded Link)

- a. Operate the crane under load in raising and lowering directions, and observe the operation of the chain and sprockets. The chain should feed smoothly into and away from the sprockets.
- b. If the chain binds, jumps, or is noisy, first see that it is clean and properly lubricated. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.
- c. The chain should be cleaned before inspection. Examine visually for gouges, nicks, weld spatter, corrosion, and distorted links. Slacken the chain and move adjacent links to one side to inspect for wear at the contact points. If wear is observed or stretching is suspected, the chain should be measured according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

1. Select an unworn, unstretched length of the chain (e.g., at the slack end).
2. Suspend the chain vertically under tension and, using a caliper-type gauge, measure

the outside length of any convenient number of links approximately 12 in. (305 mm) to 14 in. (356 mm) overall.

3. Measure the same number of links in the used sections and calculate the percentage of increase in length.

d. Conditions such as the following shall be sufficient reason for questioning safety and for considering replacement:

1. If the used chain exceeds a crane manufacturer's recommended length or, in the absence of such a recommendation, the used chain is 1.5 percent longer than the unused chain for powered hoists or is 2.5 percent longer than the unused chain for hand-operated chain, replace the chain.

2. The existence of gouges, nicks, corrosion, weld spatter, or distorted links.

e. Repairing the load chain by welding or any other means shall not be attempted by anyone other than the chain manufacturer.

f. Replacement chain shall be the same size, grade, and construction as the original chain furnished by the crane manufacturer unless otherwise recommended by the manufacturer due to working conditions.

g. Load-chain links that pass over the load sprocket on edge (alternate to those that lie flat in the pockets) should be installed with the welds away from the center of the sprocket. This precaution is not required on idler sprockets, which change the direction but not the tension in the chain.

h. The chain shall be installed without any twist between the hoist and an anchored end on either the loaded side or the slack side.

i. When a chain is replaced, disassemble and inspect the mating parts (sprockets, guides, stripper) for wear, and replace if necessary.

j. Discarded load chain shall not be used for slings.

### 7.2.7.4 Chain (Roller)

a. Test the crane under load in raising and lowering directions, observing the operation of the chain and sprockets. If the chain binds, jumps, or is noisy, clean and properly lubricate it. If the

trouble persists, inspect the chain and mating parts for wear, distortion, or damage.

b. If wear is observed or stretching is suspected, the chain shall be measured according to the crane manufacturer's instructions. If instructions are not available, proceed as follows:

1. Suspend the hoist in normal position and apply a light load of approximately 50 lb (23 kg).
2. Select a 12-in. (305-mm) section of chain that normally travels over the load sprocket.
3. Determine elongation by measuring with a caliper from the edge of one chain pin to the corresponding edge of another pin. If elongation exceeds 1/4 in. (6.3 mm) in 12 in. (305 mm) compared to new or unstretched chain values, the chain shall be replaced.
4. Inspect for twist. Replace if the twist in any 5-ft (1.52-m) section exceeds 15 degrees.
5. Check for straightness in a plane perpendicular to the plane of the rollers. Replace if the chain has a bow exceeding 1/4 in. (6.3 mm) in any 5-ft (1.52-m) section.
6. Additional inspection shall be made by removing the chain from the crane and cleaning it thoroughly. Deficiencies such as those listed below shall be carefully examined and a determination shall be made as to whether they constitute a safety hazard:

- i. Pins turned from original position.
- ii. Rollers that do not run freely with light finger pressure.
- iii. Joints that cannot be flexed by easy hand pressure.

iv. Side plates that are spread open.

v. Corrosion, pitting, or discoloration.

vi. Gouges, nicks, or weld spatter.

c. Roller chain shall be replaced if any of the conditions exist as stated in paragraphs 7.2.7.4.b., 1 through 5 above.

d. Deficiencies as stated in paragraph 7.2.7.4.b.6 above are reason for questioning chain safety and considering its replacement.

e. Repairing of roller chain by welding or heating shall not be attempted.

f. Replacement chain shall be the same size, grade, and construction as the original chain furnished by the crane manufacturer unless otherwise recommended by the manufacturer due to working conditions.

g. Roller chain, discarded or new, shall not be used for slings.

## 7.2.8 Cranes Not in Regular Service

a. Cranes that have been idle for 1 month or more but less than 6 months shall be inspected before being placed in service according to the requirements listed above in Section 7.2.6, "Frequent Inspection."

b. Cranes that have been idle for 6 months or longer shall be inspected before being placed in service according to the requirements listed above in Section 7.2.7, "Periodic Inspection."

## 7.3 TESTING

### 7.3.1 Operational Tests

a. Prior to initial use, all new, reinstalled, extensively repaired, or modified cranes shall be tested by a designated person to ensure compliance with this chapter, including the following functions:

1. Lifting and lowering.
2. Trolley travel.
3. Bridge travel.
4. Locking, limiting, and indicating devices, if provided.
5. Limit switches/devices.

b. The trip setting of hoist-limit devices shall be determined by tests with an empty hook traveling at increasing speeds up to the maximum speed. The actuating mechanism of the upper-limit device shall be located so that it will trip the device under all conditions and in sufficient time to prevent contact of the hook or load block with any part of the trolley or crane.

### 7.3.2 Rated Load Test

a. Prior to initial use, all new, reinstalled, extensively repaired, or modified cranes shall be tested by or under the direction of a qualified inspector. A designated or authorized person shall determine if repairs made to a crane are extensive, requiring a rated load test, or routine maintenance requiring only operational testing. The replacement of rope is excluded from this requirement. However, a functional test of the crane under a normal operating load should be made

prior to putting the crane back in service. A written report shall be furnished by the inspector confirming the load rating of the crane. The load rating should not be more than 80 percent of the maximum load sustained during the test. Test loads shall not be more than 125 percent of the rated capacity, unless otherwise recommended by the manufacturer. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values.

b. The rated load test for new cranes shall consist of the following operations as minimum requirements:

1. Hoist the test load a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes. Personnel shall be kept clear of the test load while it is suspended.
2. Transport the test load by means of the trolley for the full length of the bridge.
3. Transport the test load by means of the bridge for the full length of the runway, in one direction with the trolley as close to the extreme right-hand end of the crane as practical, and in the other direction with the trolley as close to the extreme left-hand end of the crane as practical.
4. Lower the test load, stopping by the brakes.

c. Extensively repaired or modified cranes shall be tested in accordance with paragraph 7.3.2.b above insofar as interfering equipment/structures permit and in accordance with recommendations from the manufacturer or a responsible engineering organization. However, test loads should not be carried over critical systems or components.

## 7.4 MAINTENANCE

### 7.4.1 Operating Equipment

- a. A preventive maintenance program shall be established and based on the recommendation of the crane manufacturer or a qualified person. Dated records should be kept where readily available to appointed personnel.
- b. Replacement parts shall be at least equal to the original manufacturer's specifications.
- c. All moving parts of the crane for which lubrication is specified shall be regularly lubricated. Check lubricating systems for delivery of lubricant. Follow manufacturer's recommendations as to points and frequency of lubrication, maintenance of lubricant levels, and types of lubricant to be used.
- d. Maintenance personnel shall take the following precautions before performing maintenance on a crane:
  1. Move the crane to a location where it will cause the least interference with other cranes and operations.
  2. Place any attached loads on the ground or floor.
  3. Place all controllers in the OFF position.
  4. Perform a lockout/tagout procedure.
  5. Use warning signs and barriers on the floor beneath the crane where overhead maintenance work creates a hazard.
  6. If the runway remains energized, place stops or signalers full-time at a visual vantage

point to observe the approach of active cranes and prohibit contact by the active cranes with the idle crane, with persons performing maintenance, or with the maintenance equipment.

7. Install a guard or barrier between adjacent runways for the length of the established work area to prevent contact between persons performing maintenance and any crane on the adjacent runway.

### 7.4.2 Wire-Rope Maintenance

Personnel using wire rope shall ensure proper care by doing the following:

- a. Store rope to prevent damage or deterioration.
- b. Unreel or uncoil rope as recommended by the rope manufacturer and with care to avoid kinking or inducing a twist.
- c. Before cutting rope, use some method to prevent unlaying the strands. Flame-cutting wire rope is prohibited.
- d. During installation, avoid dragging the rope in dirt or around objects that will scrape, nick, crush, or induce sharp bends in it.
- e. Maintain rope in a well-lubricated condition to reduce internal friction and prevent corrosion. Ensure that lubricant applied as part of a maintenance program is compatible with the original lubricant and is also a type that does not hinder visual inspection. Those sections of rope located over sheaves or otherwise hidden during inspection and maintenance procedures require special attention when the rope is being lubricated.

## 7.5 OPERATION

- a. The following shall apply to all personnel involved in overhead and gantry crane operation.
- b. At the initial stage of the planning process, an appointed person shall classify each lift into one of the DOE-specified lift categories (ordinary, critical, or preengineered production).

### 7.5.1 Conduct of Operator

- a. Do not engage in any practice that will divert your attention while operating the crane.
- b. Do not operate cranes without complying with the requirements of Chapter 6. Your immediate supervisor shall participate in this determination.
- c. Operators shall be held directly responsible for the safe operation of their equipment. Whenever there is any question as to the safety of the activity, an operator has the authority to stop and refuse to handle loads until the matter has been resolved by supervisory personnel.
- d. Sound a warning signal (if furnished) during travel, particularly when approaching personnel.
- e. If you find the crane's main or emergency switch open when starting on duty, do not close it until it has been determined that no one is on or close to the crane. If there is a warning sign on the switch, do not remove it unless you placed it there. Do not close the switch until the warning sign has been removed by the person who placed it there.
- f. Before closing the main switch, ensure that all controllers are in the OFF position.
- g. If a power failure occurs during operation, immediately switch all controllers to the OFF position.
- h. Become familiar with your equipment and its proper care. If adjustments or repairs are necessary, or any defects are known, report them promptly to the responsible supervisor. Also, notify the next operator of the defects at shift change.
- i. Contacts with runway stops or other cranes shall be made with extreme caution. If you are ordered to engage with or push other cranes, do this with particular care for the safety of persons on or below the cranes, and only after making

certain that any persons on the other cranes are aware of what action is to be taken.

- j. Secure outdoor cranes before leaving them.
- k. When the wind-indicating alarm is given, anchor the bridge on outside cranes.
- l. Lock and tag the main positive electrical control switch in the OPEN position before any crane maintenance is performed.
- m. Operate all controls before beginning a new shift. If any controls do not operate properly, adjust or repair them before operations begin.
- n. Do not hoist two or more separately rigged loads in one lift, even though the combined load is within the crane's rated capacity.
- o. Ensure that a 10BC or larger fire extinguisher is installed in the cab of cab-operated cranes. The extinguisher shall be maintained in a serviceable condition.
- p. Do not lift, lower, or travel the crane while anyone is on the load or hook.

### 7.5.2 Hoist-Limit Switch/Device

- a. At the beginning of each work shift, or the first time the crane is used during a shift, test the upper-limit switch/device of each hoist under no load. Exercise extreme care to avoid two-blocking; "inch" the block into the limit switch or run it in at slow speed. If the switch/device does not operate properly, immediately notify the supervisor.
- b. If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.
- c. Do not use the final hoist-limit switch/device that controls the upper limit of travel of the load block as an operating control.

### 7.5.3 Standard Hand Signals

The standard hand signals for DOE use shall be as specified in the latest edition of the ASME B30 standards for the particular type of crane or hoist being used (see Figure 7-4).

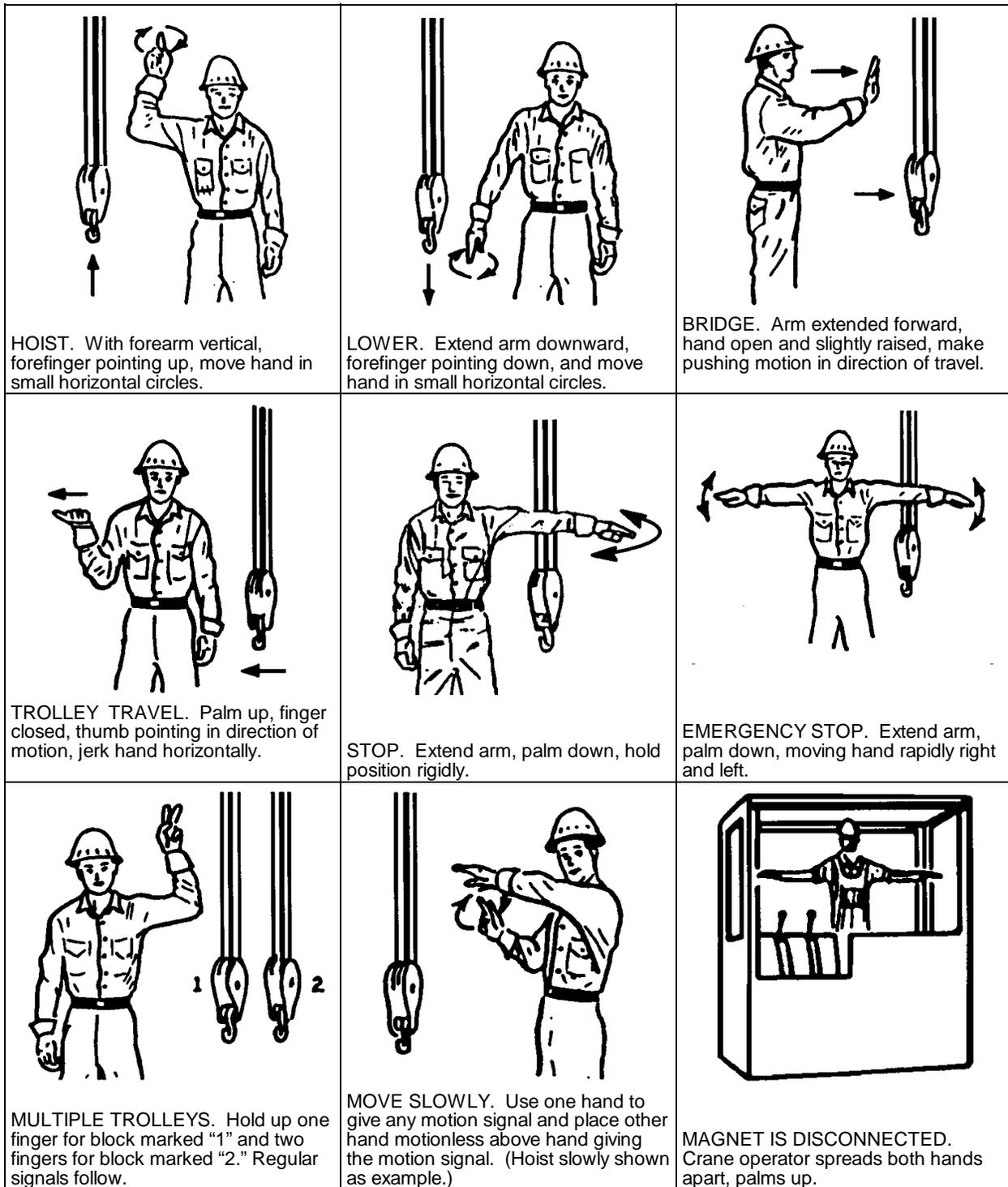


Figure 7-4. Standard hand signals for controlling overhead crane operation.

### 7.5.4 Identification of Signalers

a. All personnel acting as signalers during crane operations shall be clearly identified to the crane operator by using the following (one or more, as required by the responsible manager): orange hardhat, orange gloves, and orange vest. This requirement may be waived by the responsible manager when the lift is very closely controlled or personnel are required to wear special clothing for protection from a hazardous environment.

b. In those cases where the crane operator cannot see the signaler, a second person (relay signaler) shall be stationed where he or she can see both the signaler and the crane operator and signals can be relayed to the operator. The relay signaler shall also be clearly identified by the items described in the previous paragraph.

c. Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator, not through a third person.

d. The operator shall obey signals only from the designated signaler. *Obey a STOP signal no matter who gives it.*

### 7.5.5 Size of Load

a. The weight of the load shall be determined prior to making the lift.

b. The crane and rigging equipment shall not be loaded beyond its rated capacity, except for authorized testing described in Section 7.3.

### 7.5.6 Attaching the Load

a. Ensure that the hoist rope is free from kinks or twists. Do not wrap the hoist rope around the load.

b. Ensure the load is attached to the load-block hook by means of slings or other approved devices.

c. Take care to make certain that the sling clears all obstacles.

### 7.5.7 Moving the Load

a. The person appointed to direct the lift shall see that the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

b. Before starting to hoist, note the following conditions:

1. Hoist rope shall not be kinked.

2. Multiple-part lines shall not be twisted around each other.

3. The hook shall be positioned above the center of gravity of the load in such a manner as to minimize swinging when the load is lifted.

4. If there is a slack-rope condition, it should be determined that the rope is properly seated on the drum and in the sheaves.

5. All personnel including the qualified rigger shall be clear of the load.

c. During hoisting, take care to ensure that:

1. The load is lifted slowly until it clears the ground or other support to minimize swinging.

2. There is no sudden acceleration or deceleration of the moving load.

3. The load does not contact any obstructions. A “dry run” shall be conducted in areas where clearance is limited.

d. Cranes shall not be used for side pulls except when specifically authorized by an appointed person who has determined that the stability of the crane is not endangered and that load-bearing parts of the crane will not be overstressed.

e. Avoid carrying loads above people.

f. Each time a load approaching the rated capacity is handled, test the hoist brakes by raising the load a few inches and applying the brakes. Any slippage or downward motion is unacceptable.

g. Do not lower the hook below the point where less than two full wraps of rope remain on the hoisting drum.

h. When the load or hook approaches personnel, sound the warning signal.

i. Tag lines should be used as required to guide, snub, or otherwise control the load.

j. Place any attached load on the ground or floor, place controls in the OFF position, and turn off the power source before leaving the crane unattended, unless required to do otherwise by an approved emergency procedure.

k. Work on suspended loads is prohibited under normal conditions. If the responsible manager decides that it is necessary to work on a suspended load, guidelines for safe operation shall be established through consultation with the appropriate safety organization. Suspended loads that must be worked on shall be secured against unwanted movement.

### 7.5.8 Ordinary Lifts

a. The requirements of all preceding paragraphs in Section 7.5, "Operation," also shall apply to ordinary lifts.

b. An appointed person shall classify each lift into one of the DOE categories (ordinary, critical, or preengineered production) before the lift is planned.

c. Hoisting and rigging operations for ordinary lifts require a designated leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.

d. Leadership designation may be by written instructions, specific verbal instructions for the

particular job, or clearly defined responsibilities within the crew's organizational structure.

e. The designated leader's responsibility shall include the following:

1. Ensure that personnel involved understand how the lift is to be made.
2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.

3. Survey the lift site for hazardous/unsafe conditions.

4. Ensure that equipment is properly set up and positioned.

5. Ensure that a signaler is assigned, if required, and is identified to the operator.

6. Direct the lifting operation to ensure that the job is done safely and efficiently.

7. Stop the job when any potentially unsafe condition is recognized.

8. Direct operations if an accident or injury occurs.

f. The operator, or a designated person, shall ensure that the crane is still within the inspection interval.

g. The operator, or a designated person, shall visually examine the crane in accordance with Section 7.2.4.

### 7.5.9 Critical Lifts

See Chapter 2, "Critical Lifts," for critical-lift requirements.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

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## EXHIBIT I

BRIDGE, WALL, GANTRY CRANE LOAD TEST AND INSPECTION

EQUIPMENT NO. \_\_\_\_\_ MAKE \_\_\_\_\_ RATED CAPACITY \_\_\_\_\_ DATE \_\_\_\_\_

LOAD TEST INSPECTION REPORT

The following checklist identifies the items to be inspected prior to the load test. Any unusual conditions observed during the inspection should be noted in the Remarks section.

- NOTES:**
1. Craftsmen shall initial and date all tests, work, and inspections completed below.
  2. Qualified inspector shall verify all steps prior to load test.

NO.	CRANE ITEM	DEFECT	OK	NO.	CRANE ITEM	DEFECT	OK
1	Load Hook & Blocks			18	Controllers		
2	Wire Rope and End Connections			19	Relays and Coils		
3	Handrails, Walkways, and Ladders			20	Conductors and Collectors		
4	Bridge and Trucks			21	Panel Wiring		
5	Bridge Wheels and Bearings			22	Resistors		
6	Trolley and Rails			23	Bypass Switches		
7	Trolley Wheels and Bearings			24	Limit Switches		
8	Crane Alignment			25	Contactors (Electrical)		
9	Runway Rail & Clamps			26	Motors		
10	Bumpers/Endstops			27	Gauges		
11	Brake System			28	Lighting System		
12	Drive Shafts, Gears, Couplings & Bearings			29	Heater and Switches		
13	Pawls, Ratchets, Spuds, & Windlocks			30	Operator's Cab		
14	Sheaves			31	Safety		
15	Warning Devices			32	Chain and Sprockets		
16	Capacity Signs			33	Structural		
17	Main Disconnect			34	Wire Rope Drum and Machinery Foundation		

REMARKS (Unusual conditions—noises, structural cracks, misalignment, etc.)

---

BRIDGE CRANE AND FOLLOWUP CHECKS

- NOTES:**
1. Craftsmen shall initial all steps completed below.
  2. Qualified inspector shall verify all steps below.
  3. Load test shall be performed on all new, extensively repaired, or modified cranes prior to initial use.
  4. Load test crane at 125% of rated capacity. In no case shall the load test exceed 125% of rated capacity. Test weights shall be accurate to -5%, + 0% of stipulated values.

## INITIAL

- |       |  |
|-------|--|
| _____ | 1. Set crane up for load test and qualified inspector verify inspection is complete prior to load test.  |
| _____ | 2. The trip setting of hoist-limit devices shall be determined by tests, with an empty hook traveling at increasing speeds up to the maximum speed. The actuating mechanism of the limit device shall be located so that it will trip the device under all conditions and in sufficient time to prevent contact of the hook or load block with any part of the trolley or crane.   |
| _____ | 3. Rig test weight to hoist hook using appropriate slings.   |
| _____ | 4. Hoist the test load a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes.   |
| _____ | 5. Transport the test load by means of the trolley for the full length of the bridge. Ensure during operation that the trolley runs true on the bridge. Check trolley motor, brake, and gear case for overheating.   |
| _____ | 6. Transport the test load by means of the bridge for the full length of the runway, first in one direction with the trolley as close to the extreme right-hand end of the crane as practical and next in the other direction with the trolley as close to the extreme left-hand end of the crane as practical. Ensure that the bridge runs true on the runway rails and that no undue girder deflection occurs. Check for bridge motor, brake, and gear-case overheating. |
| _____ | 7. Move the test load back into the original position and lower the test load, stopping by the brakes. Hold the load for 10 min or the time required to check all primary load-bearing parts while under load for slippage, damage, or permanent deformation.  |
| _____ | 8. Slowly lower the test load to the floor.  |
| _____ | 9. At the completion of the load test, visually inspect the following load-bearing parts for signs of wear, deformation, and deterioration:  |

## DEFECTIVE/OK

- \_\_\_\_\_ a. Bridge track
- \_\_\_\_\_ b. Bridge wheels
- \_\_\_\_\_ c. Trolley track
- \_\_\_\_\_ d. Trolley wheels
- \_\_\_\_\_ e. Gears
- \_\_\_\_\_ f. Magnetic brakes
- \_\_\_\_\_ g. Blocks.

Visually inspect rope in accordance with Chapter 11, "Wire Rope and Slings."

- \_\_\_\_\_ a. Rope diameter: (Previous) \_\_\_\_\_ (Present) \_\_\_\_\_
- \_\_\_\_\_ b. Wear
- \_\_\_\_\_ c. Kinks
- \_\_\_\_\_ d. Broken wires
- \_\_\_\_\_ e. Other signs of deterioration.

Visually inspect the rope drum for:

- \_\_\_\_\_ a. Wear
- \_\_\_\_\_ b. Deformation
- \_\_\_\_\_ c. Deterioration.

## INITIAL

- \_\_\_\_\_ 10. Qualified inspector shall perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic-particle examination. Acceptance: No cracks, linear indications, laps, or seams.

Hooks with more than 15% normal (new hook) throat opening shall be replaced. Hooks with more than 10 degree twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the throat section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin as applicable.

Establish three marks, A, B, and C, with a center punch. For ease in measuring, set distances on an even number of inches.

EXHIBIT I (continued)

BEFORE LOAD TEST

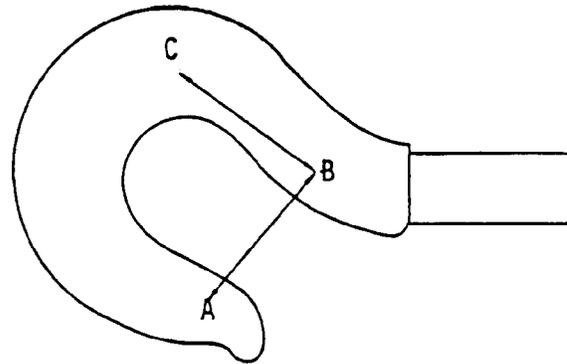
Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.

AFTER LOAD TEST

Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.



Check for:

1. Wear and deformation
2. Cracks and twisting
3. Signs of opening between Point A and Point B

Load Test Inspection Date \_\_\_\_\_

Qualified Inspector \_\_\_\_\_

Operated By \_\_\_\_\_

Actual Load Test \_\_\_\_\_ lb

# CHAPTER 8

## HOISTS

This chapter provides safety standards for inspecting, testing, and operating hoists not permanently mounted on overhead cranes and implements the requirements of ASME B30.11 (“Monorail Systems and Underhung Cranes”), B30.16 [“Overhead Hoists (Underhung)”], and B30.21 (“Manually Lever Operated Hoists”).

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## 8.1 GENERAL

a. Hoists described in this chapter include hand-powered, air-powered, and electric-powered hoists that are not permanently mounted on overhead cranes.

b. This chapter applies to the following types of equipment (see Figures 8-1 through 8-6):

1. Overhead hoists (underhung).
2. Jib cranes/hoists (floor and wall mounted).

3. Monorail systems.

4. Manual-lever-operated hoists (wire rope, chain, and web-strap types).

c. Wire-rope ratchet and pawl lever-operated hoists should not be used for lifting service (see Figure 8-8).

d. Systems used for transporting personnel and specially insulated hoists used for handling electrically energized power lines require special considerations and are not included in this chapter.

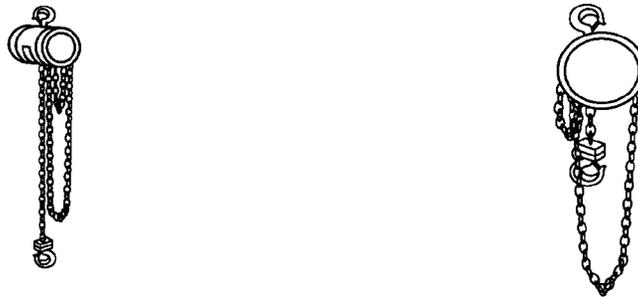


Figure 8-1. Hand-chain-operated hoists.

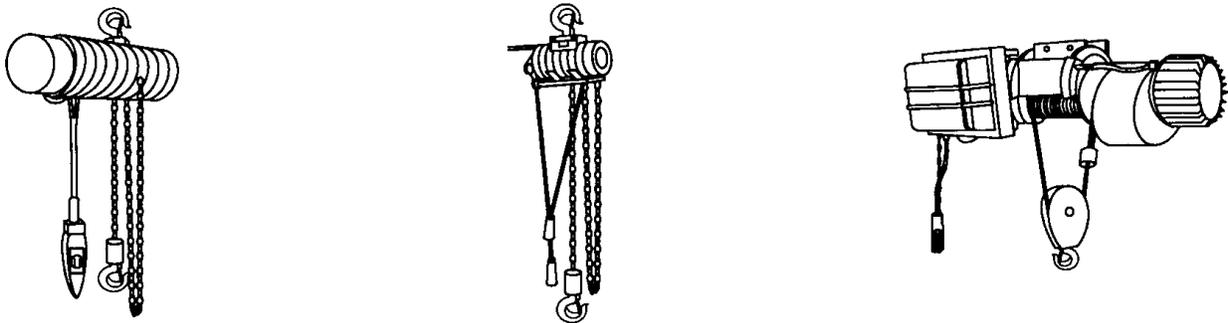


Figure 8-2. Electric/air-powered chain and wire-rope hoists.

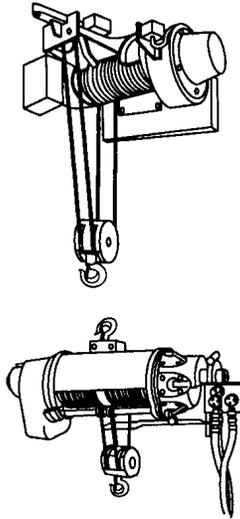


Figure 8-3. Electric/air-powered wire-rope hoists.

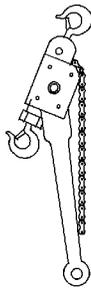


Figure 8-4. Manual-lever-operated hoist—chain type.



Figure 8-5. Manual-lever-operated hoist—wire-rope type.

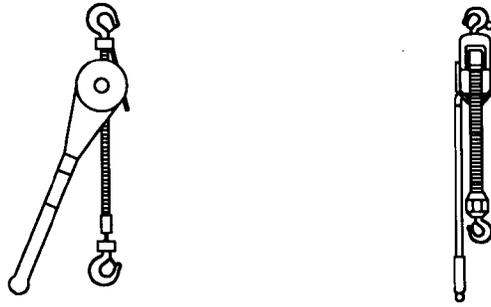


Figure 8-6. Manual-lever-operated hoist—web-strap type.

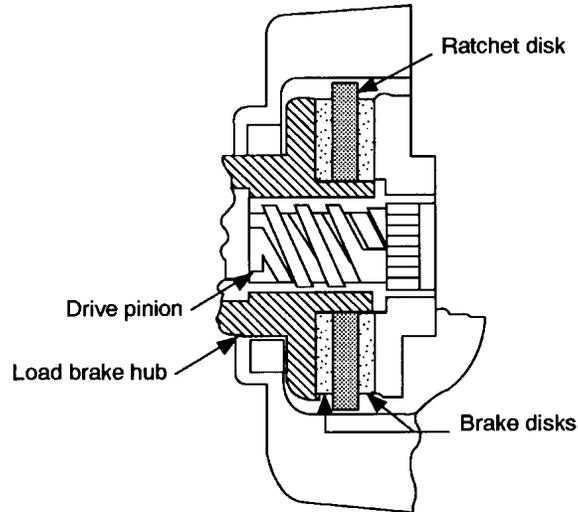


Figure 8-7. Recommended—hoists with friction brake type load-controlling mechanisms.

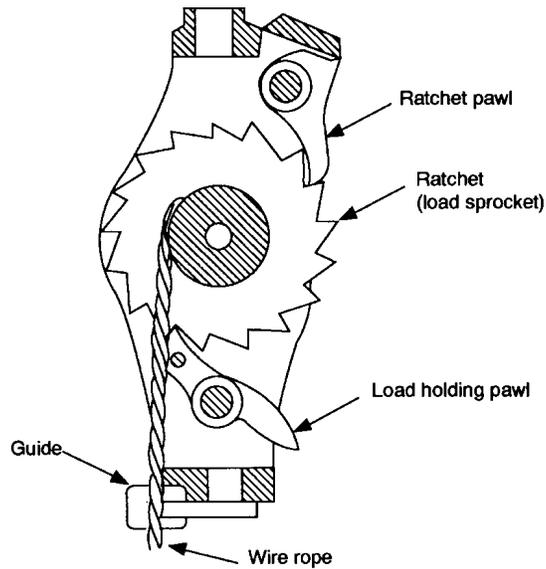


Figure 8-8. Not recommended—hoists with ratchet and pawl load-controlling mechanisms.

### 8.1.1 Operator Training/Qualification

Hoist operators shall be trained and qualified according to requirements found in Chapter 6, "Personnel Qualification and Training."

### 8.1.2 Marking

- a. The rated capacity shall be permanently marked on the hoist or load block.
- b. Electric-powered hoists shall be marked with:
  1. Name of manufacturer.
  2. Manufacturer's model or serial number.
  3. Voltage of AC or DC power supply and phase/frequency of AC power supply.
  4. Circuit ampacity.
- c. Air-powered hoists shall be marked with:
  1. Name of manufacturer.
  2. Manufacturer's model or serial number.
  3. Rated air pressure.
- d. Hand-chain-operated hoists shall be marked with:
  1. Name of manufacturer.
  2. Manufacturer's model or serial number.
- e. Manual-lever-operated hoists shall be marked with:
  1. Name of manufacturer.
  2. Manufacturer's model or serial number.

### 8.1.3 Warning Labels

Documented evidence of equivalent training of the user of the hoist, demonstrating that the information on the warning labels has been

conveyed and understood by the user, will waive the requirement to maintain warning labels.

#### 8.1.3.1 Electric- or Air-Powered Hoists

- a. Labels shall be affixed to the hoist, load block, or controls that display the word WARNING or other legend designed to bring the label to the attention of an operator.
- b. The label shall contain cautionary language against any of the following:
  1. Lifting more than the rated load.
  2. Operating a hoist when the load is not centered under the hoist.
  3. Operating a hoist with twisted, kinked, or damaged chain or wire rope.
  4. Operating a damaged or malfunctioning hoist.
  5. Lifting personnel or lifting loads above personnel.
  6. Operating a wire-rope hoist with a wire rope that is not properly seated in its grooves.
  7. Removing or obscuring warning labels.

#### 8.1.3.2 Hand-Chain-Operated or Manual-Lever-Operated Hoists

- a. Labels shall be affixed to the hoist or load block and shall display the word WARNING or other legend designed to bring the label to the attention of an operator.
- b. The label shall contain cautionary language against any of the following:
  1. Lifting more than the rated load.
  2. Operating a hoist when it is restricted from forming a straight line with the direction of loading.
  3. Operating the hoist with twisted, kinked, or damaged wire rope, chain, or webbing strap.
  4. Operating damaged or malfunctioning hoists.

5. Lifting personnel or lifting loads above personnel.
6. Operating a hoist with lever extensions (for lever-operated hoists).
7. Operating hoists with other than manual power (for hand-chain-operated hoists).
8. Removing or obscuring warning labels.

### 8.1.4 Design Standards

- a. At a minimum, safety features and operation shall meet the provisions of ASME B30.16 and B30.21.
- b. Mechanical, electrical, and structural components of hoist design shall meet accepted hoist design standards contained in ASME HST-1M, -2M, -3M, -4M, -5M, and -6M (“Performance Standard for Electric Chain Hoists”; “Performance Standard for Hand Chain Manually Operated Chain Hoists”; “Performance Standard for Manually Lever Operated Chain Hoists”; “Performance Standard for Electric Wire Rope Hoists”; “Performance Standard for Air Chain Hoists”; and “Performance Standard for Air Wire Rope Hoists,” respectively).

### 8.1.5 Design Factors

- a. For electric- or air-powered hoists, load-suspending parts of powered hoists shall be designed so that the static stress calculated for the rated load will not exceed 20 percent of the average ultimate material strength. This requirement is commonly reflected by quoting a minimum design factor of 5:1.
- b. For hand-chain-operated and manual-lever-operated hoists, load-suspending parts shall be designed so that the static stress calculated for the rated load will not exceed 25 percent of the average ultimate strength. This requirement is commonly reflected by quoting a minimum design factor of 4:1.

### 8.1.6 Load-Braking/Load-Controlling Mechanisms

#### 8.1.6.1 Electric-Powered Hoists

- a. Under normal operating conditions with rated load and under test conditions with test loads

up to 125 percent of rated load, the braking system shall perform the following functions:

1. Stop and hold the load hook when controls are released.
  2. Limit the speed of the load during lowering, with or without power, to a maximum of 120 percent of the rated lowering speed for the load being handled.
  3. Stop and hold the load hook in the event of a complete power failure.
- b. The braking system shall have thermal capacity for the frequency of operation required by the service.

- c. The braking system shall have provision for adjustments, where necessary, to compensate for wear.

#### 8.1.6.2 Air-Powered Hoists

- a. Under normal operating conditions with rated load and under test conditions with test loads up to 125 percent of rated load, the braking system shall perform the following functions:
  1. Stop and hold the load hook when controls are released.

2. Prevent an uncontrolled lowering of the load in the event of a loss of air pressure.

- b. The braking system shall have thermal capacity for the frequency of operation required by the service.

- c. The braking system shall have provision for adjustments, where necessary, to compensate for wear.

#### 8.1.6.3 Hand-Chain-Operated Hoists

The hoist shall be designed so that when the actuating force is removed, it will automatically stop and hold any test load up to 125 percent of the rated load.

#### 8.1.6.4 Manual-Lever-Operated Hoists

- a. The hoist shall be equipped with a load-controlling mechanism.
- b. The load-controlling mechanism shall perform the following functions under normal

operating conditions with test loads up to 125 percent of rated capacity:

1. Stop and hold the load when the lever force is removed and the lever stroke is completed.
  2. Provide for incremental movement of the load when lifting or lowering.
- c. The friction brake mechanism shall have provision for adjustment where necessary to compensate for wear.

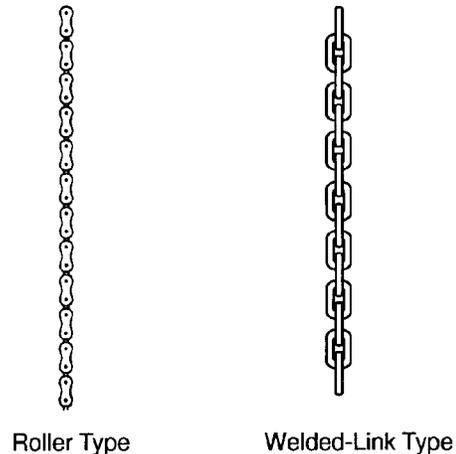
### 8.1.7 Wire Rope

- a. Wire rope shall be of a construction specified by the hoist manufacturer or by a qualified person.
- b. If a load is supported by more than one part of wire rope, the tension on the parts shall be equalized.
- c. Socketing shall be done in the manner specified by the manufacturer of the assembly or the rope.
- d. Eye splices shall be made in a manner recommended by a qualified person. Rope thimbles should be used in the eye.
- e. Swaged or compressed fittings shall be applied as recommended by the rope, hoist, or fitting manufacturer or a qualified person.
- f. Use rope having an independent wire-rope, wire-strand core, or other temperature-damage-resistant core if the rope will be exposed to ambient temperatures greater than 180 degrees F (82 degrees C).
- g. The rope ends should be attached to the hoist in a manner to prevent disengagement throughout rated hook travel. No less than two wraps of rope shall remain on the anchorage of the hoist load sprocket (drum) when the hook is in its fully extended position, unless a lower-limit device is provided, in which case one wrap shall remain on each anchorage of the drum hoist.

## 8.1.8 Load Chain

### 8.1.8.1 Electric-Powered, Air-Powered, and Manual-Lever-Operated Hoists

- a. Load chain may be either roller or welded link type (see Figure 8-9). Chain shall be pitched (calibrated) so as to pass over all load sprockets without binding.



**Figure 8-9. Load chain.**

- b. The load chain shall be proof-tested by the chain or hoist manufacturer with a load at least equivalent to 1.5 times the hoist's rated load divided by the number of chain parts supporting the load.
  - c. If a load is supported by more than one part of load chain, the tension on the parts shall be equalized.
- ### 8.1.8.2 Hand-Chain-Operated Hoists
- a. The hand chain shall be of a shape and pitch to fit the hand-chain wheel without binding or jamming under normal operating conditions.
  - b. The hand chain shall be guarded to prevent disengagement from the hand-chain wheel.
  - c. The hand chain shall withstand, without permanent distortion, a force of three times the pull required to lift the rated load.

### 8.1.9 Web Strap

The following applies for manual-lever-operated hoists:

- a. Web strap should be nylon, polyester, or similar synthetic material.
- b. If a load is supported by more than one part of web strap, the tension on the parts shall be equalized.
- c. End terminations shall be done in the manner specified by the manufacturer of the assembly or the web strap.
- d. Eyes shall be made in a manner recommended by the hoist manufacturer or a qualified person.
- e. Nylon and polyester web straps shall not be exposed to an ambient temperature greater than 200 degrees F (93 degrees C).
- f. The web strap shall be attached to the hoist in a manner to prevent disengagement throughout rated hook travel; no less than two wraps of web strap shall remain on the hoist load sprocket (drum) when the hook is extended to its full rated lift.

### 8.1.10 Overtravel Protection

#### 8.1.10.1 Upper-Limit Switches/Devices

For electric- or air-powered hoists, the hoist shall be designed and constructed so that the load hook, either loaded or empty, shall not exceed the upper limit of travel. In lieu of a limit switch, a mechanism such as a slip clutch may be used.

#### 8.1.10.2 Lower-Limit Switches/Devices

- a. For electric- or air-powered hoists, the hoist shall not be installed where, during normal

operating conditions, the hook can be lowered beyond rated hook travel unless the hoist is equipped with a lower-limit device. Lower-limit devices should be provided for hoists where the load block enters pits or hatchways in the floor.

- b. For hand-chain-operated and manual-lever-operated hoists, before the load chain can be completely run out of the hoist, it shall be restrained in its fully extended position. The restraint shall be such that the unloaded hoist can withstand a lowering hand chain or operating lever force equivalent to twice the pull required to lift the rated load, or with the rated load on the hoist, a hand chain or operating lever force equivalent to the pull required to lift the rated load.

### 8.1.11 Travel Warning Devices

On cab- and remote-operated carriers, an audible or visual warning means shall be provided, unless it is impossible for personnel to work on the floor below the hoist.

### 8.1.12 Support

Support structures, including trolleys and monorails, shall have a rated capacity at least equal to that of the hoist.

### 8.1.13 Location

The hoist shall be installed only in locations that will permit the operator to remain clear of the load at all times.

### 8.1.14 Load Rating

The rated capacity shall not be exceeded except for properly authorized tests.

## 8.2 INSPECTIONS

### 8.2.1 General

a. Frequency notation as used in dates for frequent and periodic inspections should be defined as follows:

1. Daily--24 hours.
2. Weekly--7 days.
3. Monthly--31 days.
4. Quarterly--92 days.
5. Semi-annually--184 days.
6. Yearly--365 days.

b. Violations of inspection periods may be granted on a case by case basis, provided there is a pre-established site specific policy.

### 8.2.2 Hoist Service

Hoist service is defined as follows:

a. Normal service—operation with randomly distributed loads within the rated load limit, or uniform loads less than 65 percent of rated load for not more than 15 percent of the time for manual-lever-operated hoists or for not more than 25 percent of the time for electric- or air-powered hoists.

b. Heavy service—operation within the rated capacity that exceeds normal service.

c. Severe service—operating at normal or heavy service under abnormal operating conditions, (i.e., extreme temperatures, corrosive atmospheres).

### 8.2.3 Initial Inspection

Prior to their initial use, all new, extensively repaired, or modified hoists shall be inspected by a qualified inspector to ensure compliance with the applicable provisions of ASME B30.11, B30.16, and B30.21. Dated and signed inspection records shall be kept on file and shall be readily available.

### 8.2.4 Daily Inspection

a. Operators or other designated personnel shall visually inspect items such as the following at the beginning of each shift or prior to first use if the hoist has not been in regular service (records are not required):

1. Controls and operating mechanisms for proper operation.

2. Hoist upper-limit switch, as applicable, for proper operation.

3. Lines, valves, and other parts of air systems for leakage.

4. Hooks for cracks, deformation, and damage from chemicals (see Chapter 13, “Load Hooks,” for additional hook requirements).

5. Hoist rope for kinking, crushing, birdcaging, and corrosion.

6. Hoist chain for nicks, gouges, distortion, wear, cracks, and corrosion.

7. Synthetic web strap for abrasive wear, knots, cuts, or tears, broken stitching, acid or caustic burns, melting or charring, or weld splatter.

8. Hook latch, if used, for proper operation.

b. Operators or other designated personnel shall examine deficiencies and determine whether they constitute a safety hazard.

### 8.2.5 Frequent Inspection

a. Operators or other designated personnel shall visually inspect the hoist at the following intervals (records are not required):

1. Normal service—monthly.

2. Heavy service—weekly to monthly.

3. Severe service—daily to weekly.

b. In addition to the requirements listed above in Daily Inspection, these inspections shall include the following:

1. Hoist braking system for proper operation.
  2. Hoist rope or chain reeving for compliance with hoist manufacturer's recommendations.
  3. Lever for bends, cracks, and the like
  4. Observations during operation.
- c. Examine deficiencies and determine whether a more detailed inspection is required.

### 8.2.6 Periodic Inspection

- a. A qualified inspector shall perform a complete inspection at the following intervals:
1. Normal service—yearly.
  2. Heavy service—semiannually.
  3. Severe service—quarterly.
- b. The qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard and whether disassembly is required.
- c. Dated and signed inspection records shall be kept on file and shall be readily available.
- d. A sample load test and inspection form is included as Exhibit I, which appears at the end of this chapter. This form is intended to be a sample only and is not intended to be mandatory.

#### 8.2.6.1 Hoists

- a. In addition to the requirements listed in Section 8.2.4, "Frequent Inspection," periodic inspections of hoists shall include the following:
1. Loose fasteners.
  2. Cracked or worn drums or sheaves.
  3. Worn, corroded, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers locking, and clamping devices.
  4. Excessive wear on motor or load brakes.

5. Excessive wear of chains, ropes, synthetic web strap, load sprockets, drums, sheaves, and chain stretch.
6. Deterioration or damage of end connections and terminations of wire rope, load chains, and synthetic web.
7. Hooks having more than 15 percent in excess of normal throat opening, or more than 10 degree twist from the plane of the unbent hook (see Chapter 13 for additional hook requirements).
8. Hook-retaining nuts or collars and pins, welds, or riveting used to secure the retaining members.
9. Suitable crack-detecting inspections for hooks, such as dye-penetrant or magnetic-particle inspections (performed when required by the inspector).
10. Electrical apparatus for signs of pitting or any deterioration of controller contactors, limit switches, and push-button switches.
11. Supporting structures and trolleys, if used, for continued ability to support the imposed loads.
12. Warning labels for illegibility or absence.

#### 8.2.6.2 Wire Rope

- a. A qualified inspector shall inspect running rope at least annually. This inspection shall include examination of the entire length of rope, without detaching it from the hoist drum. More frequent intervals shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by experience on the particular installation or similar installations, severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration, such as described below, resulting in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk.
1. Reduction of rope size below nominal diameter, whether due to loss of core support, internal or external corrosion, or wear of outside wires (see Table 8-1).

2. A number of broken outside wires and the distribution or concentration of such broken wires.
3. Worn outside wires.
4. Sections of rope that are normally hidden during inspection or maintenance procedures, such as parts passing over sheaves (these are points most subject to deterioration).
5. Corroded or broken wires at end connections.
6. Corroded, cracked, bent, worn, or improperly applied end connections.

1. In hoist ropes, 12 randomly distributed broken wires in one rope lay, or 4 broken wires in one strand in one rope lay.
2. Wear of one-third of the original diameter of outside individual wires.
3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
4. Evidence of heat damage from any cause.
5. Reductions from nominal diameter greater than those shown in Table 8-1.

**Table 8-1. Maximum allowable rope reductions.**

Rope diameter	Maximum allowable reduction from nominal diameter
Up to 5/16 in. (8 mm)	1/64 in. (0.4 mm)
Over 5/16 in. to 1/2 in. (13 mm)	1/32 in. (0.8 mm)
Over 1/2 in. to 3/4 in. (19 mm)	3/64 in. (1.2 mm)
Over 3/4 in. to 1 1/8 in. (29 mm)	1/16 in. (1.6 mm)
Over 1 1/8 in. to 1 1/2 in. (38 mm)	3/32 in. (2.4 mm)

7. Kinking, crushing, cutting, or unstranding.
- b. No precise rules can be given for determining the exact time to replace wire rope because many factors are involved. Safety depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.
- c. Conditions such as the following shall be reason for questioning rope safety and considering replacement:

- d. The qualified inspector shall give special attention to end fastenings and shall examine ropes frequently at socketed fittings; on the development of two broken wires adjacent to this point, resocket or replace the rope. Resocketing shall not be attempted if the resulting rope length will be insufficient for proper operation. Those portions of the rope subjected to reverse bends and operation over small-diameter drums or sheaves shall be closely examined.
- e. Replacement rope and connections shall have a strength rating at least as great as the original rope and connections furnished by the hoist manufacturer. Any deviation from the original size, grade, or construction shall be specified by a rope manufacturer, the hoist manufacturer, or a qualified person.
- f. Never use discarded rope for slings.

**8.2.6.3 Welded-Link Chain**

- a. A qualified inspector shall do the following during periodic inspections:
1. Operate the hoist under load in raising and lowering directions, and observe the operation of the chain and sprockets. The chain should feed smoothly into and away from the sprockets.
  2. Make sure that, if the chain binds, jumps, or is noisy, first clean and properly lubricate it. If the trouble persists, inspect the chain and mating parts for wear, distortion, or other damage.
  3. The chain should be cleaned before inspection. Examine visually for cracks, gouges, nicks, weld spatter, corrosion, and distorted links.

Slacken the chain and move adjacent links to one side to inspect for wear at the contact points. If you observe wear or suspect stretching, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

- i. Select an unworn, unstretched length of the chain (e.g., at the slack end).
  - ii. Suspend the chain vertically under tension and, using a caliper-type gauge, measure the outside length of any convenient number of links approximately 12 in. (305 mm) to 14 in. (356 mm) overall.
  - iii. Measure the same number of links in the used sections and calculate the percentage of increase in length.
  - iv. If the used chain exceeds a hoist manufacturer's recommended length, or in the absence of such a recommendation, if the used chain is 1.5 percent longer than the unused chain for powered hoists or is 2.5 percent longer than the unused chain for hand-operated hoists, replace the chain.
  - v. Examine the chain for gouges, nicks, corrosion, weld spatter, or distorted links. Any of these conditions shall be sufficient reason for questioning safety and considering replacement. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating the degree of damage.
4. No one except the chain manufacturer shall repair the load chain by welding or any other means.
5. Ensure that replacement chain is the same size, grade, and construction as the original chain furnished by the hoist manufacturer, unless otherwise recommended by the hoist manufacturer due to working conditions.

6. Load-chain links that pass over the hoist-load sprocket on edge (alternate to those that lie flat in the pockets) should be installed with the welds away from the center of the sprocket. This precaution is not required on idler sprockets, which change the direction but not the tension in the chain.

7. Ensure that replacement chain is installed without any twist between the hoist and an anchored end on either the loaded side or the slack side.

8. When a chain is replaced, disassemble and inspect the mating parts (sprockets, guides, stripper) for wear, and replace if necessary.

9. Never use discarded load chain for slings.

#### 8.2.6.4 Roller Chain

a. A qualified inspector shall do the following during periodic inspections:

1. Test the hoist under load in raising and lowering directions, observing the operation of the chain and sprockets. If the chain binds, jumps, or is noisy, clean and properly lubricate it. If the trouble persists, inspect the chain and mating parts for wear, distortion, or damage.

2. If you observe wear or suspect stretching, measure the chain according to the hoist manufacturer's instructions. If instructions are not available, proceed as follows:

- i. Suspend the hoist in normal position and apply a light load of approximately 100 lb (46 kg).
- ii. Select a 12-in. (305-mm) section of chain that normally travels over the load sprocket.
- iii. Determine elongation by measuring with a caliper from the edge of one chain pin to the corresponding edge of another pin. If elongation exceeds 1/4 in. (6.3 mm) in 12 in. (305 mm) compared to new or unstretched chain values, replace the chain.

- iv. Inspect for twists. Replace if the twist in any 5-ft (1.52-m) section exceeds 15 degrees.
- v. Check for straightness in a plane perpendicular to the plane of the rollers. Replace if the chain has a bow exceeding 1/4 in. (6.3 mm) in any 5-ft (1.52-m) section.

3. Make additional inspections by removing the chain from the hoist and cleaning it thoroughly. Carefully examine deficiencies such as those listed below and determine whether they constitute a safety hazard. Any deficiencies are reason for questioning chain safety and considering its replacement.

- i. Pins turned from original position.
- ii. Rollers that do not run freely with light finger pressure.
- iii. Joints that cannot be flexed by easy hand pressure.
- iv. Side plates that are spread open.
- v. Corrosion, pitting, or discoloration.
- vi. Gouges, nicks, or weld spatter.

4. Do not attempt to repair roller chain by welding or heating.

5. Ensure that replacement chain is the same size, grade, and construction as the original chain furnished by the hoist manufacturer unless otherwise recommended by the hoist manufacturer due to working conditions.

6. Never use discarded or new roller chain for slings.

#### 8.2.6.5 Synthetic-Web Strap

a. No precise rules can be given for determining the exact time to replace web strap.

Safety depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used web, after allowance for deterioration disclosed by inspection.

b. Conditions such as the following shall be reason for questioning continued use of the web strap or increasing the frequency of inspection:

- 1. Severely worn end connections.
- 2. Distortion of the web-strap structure.
- 3. Evidence of any heat damage.

c. The web strap shall be removed from service when damage such as the following is discovered:

- 1. Melting or charring.
- 2. Acid or caustic burns.
- 3. Weld spatter.
- 4. Broken stitching.
- 5. Cuts or tears.
- 6. Damaged eyes or fittings.
- 7. Abrasive wear.
- 8. Knots.

### 8.2.7 Hoists Not in Regular Service

a. A hoist that is not in regular service (idle for a period of 1 month or more, but less than 1 year) shall be inspected before being placed in service according to the requirements listed above in Section 8.2.5, "Frequent Inspection."

b. A hoist that is not in regular service (idle for a period of 1 year or more) shall be inspected before being placed in service according to the requirements listed above in Section 8.2.6, "Periodic Inspection."

## 8.3 TESTING

### 8.3.1 Operational Tests

All new hoists shall be tested by the hoist manufacturer. All modified or extensively repaired hoists or hoists that have not been used within the preceding 12 months shall be tested before being placed in service. All tests shall be done by a qualified inspector or under the direction of that inspector as detailed in the following paragraphs.

#### 8.3.1.1 Electric- or Air-Powered Hoists

- a. Check lifting and lowering (testing through complete rated lift length is not required).
- b. Check operation of brakes.
- c. Determine the trip-setting of limit devices by tests under no-load conditions. Conduct tests first by hand, if practical, and then under slowest speed obtainable. Test with increasing speeds up to maximum speed.

#### 8.3.1.2 Hand-Chain-Operated Hoists

- a. Check all functions of the hoist, including lifting and lowering, with the hoist suspended in an unloaded state.
- b. After testing unloaded, apply a load of at least 50 lb (23 kg) multiplied by the number of load-supporting parts of chain to the hoist to check proper load control.

#### 8.3.1.3 Manual-Lever-Operated Hoists

- a. Check all functions of the hoist with the hoist suspended in an unloaded state.
- b. After testing unloaded, apply a load of at least 100 lb (46 kg) multiplied by the number of load-supporting parts of load line to the hoist to check proper load control.

### 8.3.2 Proof-Load Test

Test anchorages or suspensions shall be approved by a qualified person.

#### 8.3.2.1 Electric- or Air-Powered Hoists

- a. The manufacturer shall dynamically test new hoists as specified in Section 8.3.1.1 (“Electric- or Air-Powered Hoists”), steps a. and b., with a test load of at least 125 percent of the rated load. If the manufacturer cannot test the hoist, the user

shall be notified and the test shall be accomplished at another location or job site by a qualified inspector or under the direction of that inspector.

- b. A qualified inspector shall test hoists in which load suspension parts have been modified, replaced, or extensively repaired as specified in Section 8.3.1.1, steps a. and b. by or under the direction of a qualified inspector, and a record of the test should be made. A designated or authorized person shall determine if repairs made to a hoist are extensive, and require a rated load test, or routine maintenance and require only an operational test. The applied test load shall not be less than 100 percent of the rated capacity of the hoist, or more than 125 percent of the rated capacity of the hoist unless otherwise recommended by the manufacturer or a qualified person. The replacement of load chain and rope is specifically excluded from this hoist test; however, a functional test of the hoist under a normal operating load should be made in accordance with 8.3.1., “Operational Tests,” prior to putting the hoist back in service.

#### 8.3.2.2 Hand-Chain-Operated or Manual-Lever-Operated Hoists

- a. The manufacturer shall dynamically test new hoists with a test load of at least 125 percent of the rated capacity. If the manufacturer cannot test the hoist, the user shall be notified and the test shall be accomplished at another location or job site by a qualified inspector or under the direction of that inspector.
- b. Hoists in which load suspension parts have been modified, replaced, or extensively repaired shall be tested statically or dynamically by or under the direction of a qualified inspector, and a record of the test should be kept. A designated or authorized person shall determine if repairs made to a hoist are extensive and require a rated load test or are routine maintenance and require only an operational test. The applied test load shall not be less than 100 percent of the rated capacity of the hoist or more than 125 percent of the rated capacity of the hoist, unless otherwise recommended by the manufacturer or a qualified person. The replacement of load chain is specifically excluded from this hoist load test; however, a functional test of the hoist should be made in accordance with Section 8.3.1.2 or 8.3.1.3 (“Hand-Chain-Operated Hoists” and “Manually Lever-Operated Hoists,” respectively), prior to putting the hoist back in service.

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## **8.4 MAINTENANCE**

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a. A preventive maintenance program shall be established and be based on the hoist manufacturer's recommendations.

b. Replacement parts shall be at least equal to the original manufacturer's specifications.

## 8.5 OPERATION

- a. The following shall apply to all personnel involved in hoist operations.
- b. At the initial stage of the planning process, an appointed person shall classify each lift into one of the DOE-specified categories (ordinary, critical, or preengineered production).

### 8.5.1 Conduct of Operator

- a. Do not engage in any practice that will divert your attention while engaged in operating the hoist.
- b. Do not operate equipment if you are physically or mentally unfit.
- c. Familiarize yourself with the equipment and its proper care. If adjustments or repairs are necessary or any damage is known or suspected, report it promptly to the appointed person. Notify the next operator of the problem upon changing shifts. Correct deficiencies before resuming normal operation.
- d. Test all controls before beginning a shift. If any controls do not operate properly, adjust or repair them before beginning operations.
- e. Operators are responsible for those operations under their direct control. Whenever there is doubt as to safety, consult with responsible management before handling the load.
- f. Do not operate a hoist that bears an out-of-order sign or is otherwise tagged out-of-service.
- g. If there is a tag, sign, or lock on electric- or air-powered equipment, do not energize the equipment until the tag, sign, or lock is removed by the person who placed it there or by an authorized person.
- h. Do not close the main line disconnect device on powered equipment until you are certain that no one is on or adjacent to the hoist or carrier.

### 8.5.2 Size of Load

Know the weight of the load and do not load the hoist beyond the rated capacity, except as provided for in Section 8.3, "Testing."

### 8.5.3 Attaching the Load

- a. The supporting structure or anchoring means shall have a load rating at least equal to that of the hoist.
- b. Use hoists only in areas that will allow you to be clear of the load.
- c. Do not wrap the hoist rope or chain around the load.
- d. Attach the load to the hook using slings or other approved devices.
- e. Do not use chain or wire rope as a ground for welding.
- f. Do not touch a welding electrode to the chain, wire rope, or any other part of the hoist or monorail system.
- g. Operate hand-chain-operated hoists with hand power only and with no more than one operator per hand chain.
- h. Do not use a lever extension ("cheater") on manual-lever-operated hoists.
- i. Properly seat the slings or other approved devices in the saddle of the hook before carrying out hoisting operations.

### 8.5.4 Moving the Load

- a. Take care in hoisting to be certain that:
  1. Hoist ropes or chains are not kinked or twisted.
  2. The load does not contact any obstructions.
  3. Multiple-part ropes or chains are not twisted around each other.
- b. Before starting to hoist, ensure that the rope or chain is properly seated on the drum, sheaves, or sprockets.
- c. Before starting the hoist, be certain that all personnel are clear of the equipment.

- d. Do not operate hoists until the hook is positioned above the center of gravity of the load, except when specifically authorized by an appointed person who has determined that the components of the hoist and its mounting will not be overstressed.
- e. Do not move or lift a load more than a few inches until it is well balanced in a sling or lifting device.
- f. Do not lift, lower, or travel the hoist while anyone is on the load or hook.
- g. Avoid carrying loads above personnel.
- h. Test the brakes each time a load approaching the rated capacity is handled by raising the load just enough to clear the floor or supports and checking for brake action. Continue the lift only after you are sure that the braking system is operating properly.
- i. Do not lower a loaded wire-rope hoist drum beyond the point where less than two full wraps of wire rope remain on the drum.
- j. Inch the hoist into engagement with a load, and avoid unnecessary stops and starts.
- k. Do not perform side pulls with hoists except as specifically authorized by a qualified person.
- l. If power goes off during operation of cab-operated equipment, immediately place all controllers in the OFF position. Before reuse, check operating motions for proper direction.
- m. Do not leave a suspended load unattended unless specific precautions have been instituted and are in place.
- n. Tag lines should be used as required to guide, snub, or otherwise control the load.
- o. Take signals from only one person using the standard hand signals shown in Chapter 7, "Overhead and Gantry Cranes." *Obey a STOP signal regardless of who gives it.*
- p. Lift the hoist load block above head level for storage when the equipment is not in use.

### 8.5.5 Hoist-Limit Switch

- a. At the beginning of a shift, test the upper-limit switch of each hoist under no load conditions. If the hoist has a lower-limit switch,

test it with no load before lowering any load that could bring the lower-limit switch into operation. Exercise extreme care; inch the block into the limit switch or run in at slow speed. If the limit switch does not operate properly, notify the designated person immediately.

- b. If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.

- c. Never use the hoist-limit switch that controls the upper limit of travel of the load block as an operating control.

### 8.5.6 Ordinary Lifts

- a. Hoisting and rigging operations for ordinary lifts require a designated leader. The designated leader shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.

- b. Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the crew's organizational structure.

- c. The designated leader's responsibility shall include the following:

1. Ensure that personnel involved understand how the lift is to be made.
2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.
3. Survey the lift site for hazardous/unsafe conditions.
4. Ensure that equipment is properly set up and positioned.
5. Ensure that a signaller is assigned, if required, and is identified to the operator.
6. Direct the lifting operation to ensure that the job is done safely and efficiently.
7. Stop the job when any potentially unsafe condition is recognized.

8. Direct operations if an accident or injury occurs.

d. The operator or other designated person shall visually examine the hoist in accordance with the requirements for a daily inspection described in Section 8.2, "Inspections."

e. A qualified person shall examine any deficiencies and determine whether they constitute a hazard. Correct these deficiencies before operating the hoist.

f. Load lines shall be checked after strain is put on them, before the load is lifted clear of the ground. If not plumb, the slings or equipment shall be repositioned so that the lines are plumb before continuing.

### **8.5.7 Critical Lifts**

See Chapter 2, "Critical Lifts," for critical-lift requirements.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

HOIST LOAD TEST AND INSPECTION

INSPECTED BY \_\_\_\_\_  
 HOIST ID# \_\_\_\_\_ LOCATION \_\_\_\_\_ DATE \_\_\_\_\_

- NOTES:**
1. Load test prior to initial use, at 125% of rated capacity, all new hoists or hoists in which load-sustaining parts have been modified, repaired, or replaced. Test weights shall be accurate to within -5%, +0% of stipulated values. Load test at 100% of rated capacity hoists with overload devices. Test the function of the overload device.
  2. Qualified inspector shall verify all steps as listed below.
  3. Craftsmen will initial all tests, work, and inspections completed below.

- 
- 
- \_\_\_\_\_ 1. Perform the annual periodic inspection. Check unit for proper operation.
  - \_\_\_\_\_ 2. **HAND-CHAIN-OPERATED HOISTS ONLY.** Check brake mechanism for work glazed, or contaminated disks, worn pawls, cams, or ratchets. Check for broken, corroded, or stretched pawl springs. Repair as needed.
  - \_\_\_\_\_ 3. **ELECTRIC- AND AIR-POWERED HOISTS.** Check:
    - a. All functional operating mechanisms for misadjustment interfering with proper operation
    - b. Limit switches or devices for proper operation
    - c. External evidence of damage or excessive wear of load sprockets, idler sprockets, and drums or sheaves
    - d. External evidence of wear on motor or load brake
    - e. Electrical apparatus for signs of pitting or any deterioration of visible controller contacts
    - f. All anchorage or hoist suspensions.
  - \_\_\_\_\_ 4. Set hoist up for load test and inspection. Where applicable, ensure that the load chart is legible.
  - \_\_\_\_\_ 5. Perform load test using the required test weights (see Note 1) and appropriate slings. Measure a length of the load chain under tension; measure a length of 15 links. If wire rope is used, measure the diameter.

IF HOIST IS EQUIPPED WITH A TROLLEY:

- \_\_\_\_\_ 1. Mount hoist on a monorail.
- \_\_\_\_\_ 2. Rig test weight to load hook (see step 4 above).
- \_\_\_\_\_ 3. Perform load test moving weight along monorail. Observe hoist and trolley. Observe performance of all load-bearing components.
- \_\_\_\_\_ 4. Lower test weight to floor. Note performance of hoist during lowering operation. Remove rigging.

**EXHIBIT I (continued)**

HOIST LOAD TEST AND INSPECTION

At the completion of the load test, inspect the following items.

1. Visually inspect and remeasure the load chain and/or hoist rope after the load test. Check for deformed or broken links, stretch, etc.
2. Inspect load hook and suspension hook for bending or twisting.

LOAD HOOK:                      PREVIOUS                      PRESENT

Qualified Inspector Verify \_\_\_\_\_ Throat Opening \_\_\_\_\_

Qualified Inspector Verify \_\_\_\_\_ Hook Twist \_\_\_\_\_

SUSPENSION HOOK:

Qualified Inspector Verify \_\_\_\_\_ Throat Opening \_\_\_\_\_

Qualified Inspector Verify \_\_\_\_\_ Hook Twist \_\_\_\_\_

Qualified inspector shall perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

Hooks with more than 15% normal (new hook) throat opening shall be replaced. Hooks with more than 10 degree twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the bowl section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin as applicable.

Establish three marks, A, B, and C, with a center punch. For ease in measuring, set distances on an even number of inches.

BEFORE LOAD TEST

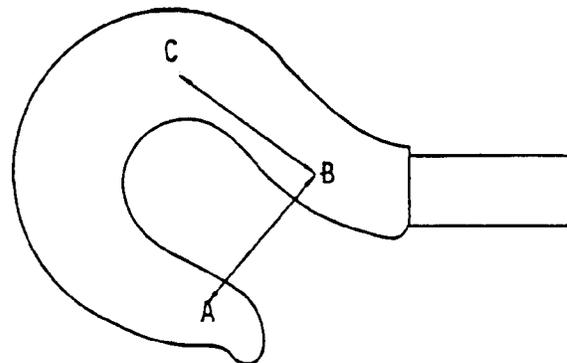
Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.

AFTER LOAD TEST

Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.



Check for:

1. Wear and deformation
2. Cracks
3. Signs of opening between Point A and Point B.

Equipment Operator \_\_\_\_\_

Actual Load Test \_\_\_\_\_ lb    Qualified Inspector Verify Load Test \_\_\_\_\_    Date \_\_\_\_\_

# CHAPTER 9

## MOBILE CRANES

This chapter specifies operation, inspection, maintenance, and testing requirements for the use of mobile cranes and implements the requirements of ASME B30.5 (“Mobile and Locomotive Cranes”). Only equipment built to appropriate design standards shall be used at DOE installations.

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## 9.1 GENERAL

This chapter applies to commercial truck-mounted cranes; crawler cranes; locomotive cranes; wheel-mounted cranes, multiple control stations; wheel-mounted cranes, single control station; and any variation that retains the same fundamental characteristics. These cranes have a superstructure capable of rotating 360 degrees mounted on a carrier and have boom raising and lowering capabilities.

### 9.1.1 Operator Training/Qualification

Operators of mobile cranes shall be trained and qualified as required in Chapter 6, "Personnel Qualification and Training."

### 9.1.2 Load Limits

a. Since the load rating for mobile cranes may be based on stability and hydraulic or structural competence, load ratings established by the manufacturers shall not be exceeded in operational application.

b. No crane shall be loaded beyond its rated capacity, except for load test purposes as described in Section 9.3, "Testing."

c. When loads are to be handled that are limited by hydraulic or structural competence rather than by stability, the appointed person shall ensure that the weight of a load approaching rated capacity has been determined within -10 percent, +0 percent before it is lifted.

### 9.1.3 Load Rating Chart

a. A durable rating chart with legible letters and figures shall be provided with each crane and attached in a location accessible to the operator while at the controls. See Table 9-1 for a sample load rating chart. The data and information to be provided on these charts shall include, but not be limited to, the following:

1. A full and complete range of manufacturer's crane load ratings at all stated operating radii, boom angles, work areas, and all stated boom lengths and configurations, jib lengths and angles (or offset), as well as alternate ratings for use and nonuse of optional equipment on the crane, such as outriggers and extra counterweights, that affect ratings.

2. A work area chart for which capacities are listed in the load rating chart (see sample in Figure 9-1).

3. Where ratings are limited by structural, hydraulic, or factors other than stability, the limitations shall be shown and emphasized on the rating charts.

4. In areas where no load is to be handled, the work area figure and load rating chart shall state that information.

5. Recommended reeving for the hoist lines shall be shown.

b. In addition to the data required on the load rating chart, the following information shall be shown either on the rating chart or in the operating manual:

1. Recommended parts of the hoist reeving, and size and type of rope for various crane loads.

2. Recommended boom hoist reeving diagram, where applicable; size, type, and length of rope.

3. Tire pressure, where applicable.

4. Cautionary or warning notes relative to limitations on equipment and operating procedures, including indication of the least stable direction.

5. Position of the gantry and requirements for intermediate boom suspension, where applicable.

6. Instructions for boom erection and conditions under which the boom, or boom and jib combinations, may be raised or lowered.

7. Whether the hoist-holding mechanism is automatically controlled or manually controlled, whether free-fall is available, and whether any combination of those exists.

8. The maximum telescopic travel length of each boom telescopic section.

9. Whether sections are telescoped with power or manually.

**Table 9-1. Sample load rating chart.**

This table is an example of the type of load rating chart that should be included in each crane.

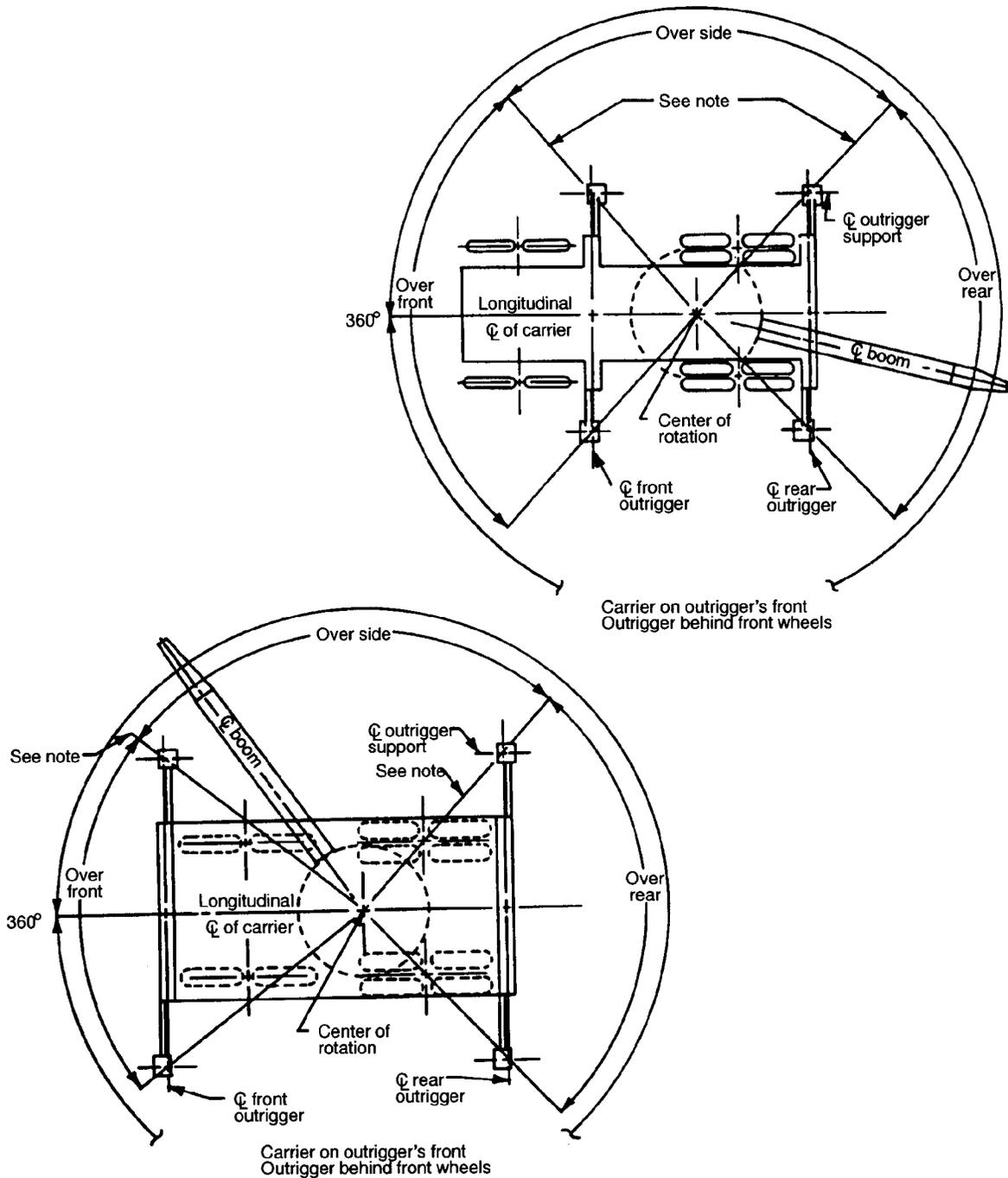
Manitowoc Model 3900 Liftcrane Extra-Heavy Boom

Working radius	50'	60'	70'	80' lbs.	90'	100'	120'	140'
12	120 000	120 000						
14	111 200	110 800	109 000					
16	104 200	103 600	102 700	100 000	95 000			
18	97 800	97 400	97 000	96 600	92 500	90 000		
20	93 200	92 400	91 600	90 600	89 600	86 000	83 000	
22	87 800	86 800	85 800	84 800	83 800	82 800	80 000	
24	<u>83 400</u>	81 200	80 300	79 400	78 700	77 800	75 200	66 500
26	75 900	<u>75 500</u>	<u>74 700</u>	<u>73 900</u>	<u>73 200</u>	<u>72 600</u>	70 500	63 100
28	68 100	67 700	67 300	66 900	66 400	65 800	64 000	59 800
30	61 700	61 300	60 900	60 500	60 000	59 400	<u>58 500</u>	<u>56 400</u>
32	56 500	56 100	55 700	55 300	54 800	54 200	53 300	52 300
34	52 000	51 600	51 200	50 800	50 300	49 700	48 800	47 800
36	48 100	47 700	47 300	46 900	46 400	45 800	44 900	43 900
38	44 700	44 300	43 900	43 500	43 000	42 400	41 500	40 500
40	41 700	41 300	40 900	40 500	40 000	39 400	38 500	37 500
42	39 100	38 700	38 300	37 900	37 400	36 800	35 900	34 900
44	36 800	36 400	36 000	35 600	35 100	34 500	33 600	32 600
46	34 700	34 300	33 900	33 500	33 000	32 400	31 500	30 500
48	32 900	32 500	32 100	31 700	31 200	30 600	29 700	28 700
50	<u>31 200</u>	30 800	30 400	30 000	29 500	28 900	28 000	27 000
52		29 300	28 900	28 500	28 000	27 400	26 500	25 500
54		27 900	27 500	27 100	26 600	26 000	25 100	24 100
56		26 500	26 100	25 700	25 200	24 600	23 700	22 700
58		25 300	24 900	24 500	24 000	23 400	22 500	21 500
60		<u>24 200</u>	23 800	23 400	22 900	22 300	21 400	20 400
65			21 300	20 900	20 400	19 800	18 900	17 900
70			<u>19 300</u>	18 900	18 400	17 800	16 900	15 900
75				17 100	16 600	16 000	15 100	14 100
80				<u>15 700</u>	15 200	14 600	13 700	12 700
85					13 900	13 300	12 400	11 400
90					<u>12 700</u>	12 100	11 200	10 200
95						11 100	10 200	9 200
100						<u>10 200</u>	<u>9 300</u>	<u>8 300</u>
110							6 800	5 600
120							4 500	3 840

**NOTES:**

a. Above ratings are maximum recommended working loads. Loads between solid lines are computed at 75% of tipping load across treads; with machine on firm, level ground. Loads outside solid lines are limited by strength of boom.

b. For booms 80 ft and longer, use cambered center section; for booms 100 ft and longer, use deep section inserts.



Note: These lines determine the limiting position of any load for operation within working areas indicated.

Figure 9-1. Sample work area chart.

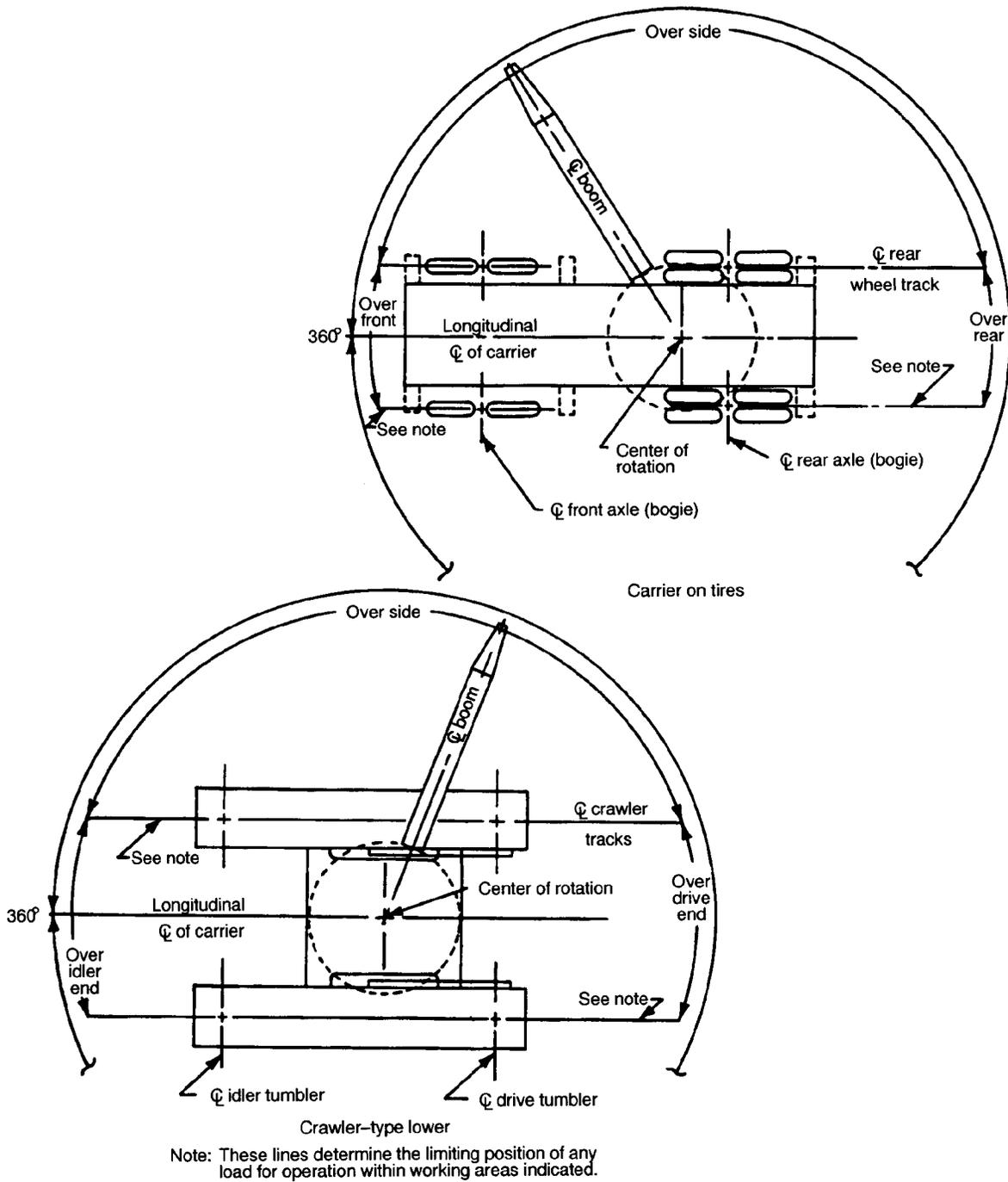


Figure 9-1. (continued).

10. The sequence and procedure for extending and retracting the telescopic boom section.

11. Maximum loads permitted during the actual boom-extending operation and any limiting conditions or cautions.

12. Hydraulic relief valve settings specified by the manufacturer.

### 9.1.4 Load Hoist Brakes

When power-operated brakes that have no continuous mechanical linkage between the actuating and braking means are used, an automatic means shall be provided to set the brake to prevent the load from falling in event of loss of brake-actuating power.

### 9.1.5 Power-Controlled Lowering

A power-controlled lowering system shall be provided and shall be capable of handling rated loads and speeds as specified by the manufacturer of the crane.

### 9.1.6 Booms

a. Booms, boom sections, and jibs shall be clearly identified and shall be used only for the purpose recommended by the manufacturer.

b. Lattice booms shall meet the performance requirements of SAE J987, "Crane Structure, Method of Test" (see Chapter 16, "References").

### 9.1.7 Rerating

a. Cranes may be modified or rerated providing such modifications are analyzed thoroughly by a qualified engineer or manufacturer of cranes. Such action must be approved by the cognizant safety organization.

b. When rerated, crawler, truck, and wheel-mounted cranes shall be tested in accordance with SAE J765, "Crane Load Stability Test Code."

c. A rerating test report shall be readily available.

d. No cranes shall be rerated in excess of the manufacturer's original load ratings.

### 9.1.8 Maintenance History

The maintenance history of the crane shall be retained throughout its service life.

### 9.1.9 Design Standards

a. Structural, mechanical, and electrical components of the crane design shall meet accepted crane design standards, such as PCSA-4, "Mobile Power Crane and Excavator Standards and Hydraulic Crane Standards."

b. The safety features and operation shall conform, at a minimum, to the provisions of ASME B30.5, "Mobile and Locomotive Cranes."

## 9.2 INSPECTIONS

### 9.2.1 General

a. Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, gross shimmy, or irregularity. There shall be no apparent damage, excessive wear, or deformation of any load-bearing part of the equipment. All safety devices, load indicators, boom angle and radius indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.

b. Frequency notations as used in dates for frequent and periodic inspections should be defined as follows:

1. Daily--24 hours.
2. Weekly--7 days.
3. Monthly--31 days.
4. Quarterly--92 days.
5. Semi-annually--184 days.
6. Yearly--365 days.

c. Violations of inspection periods may be granted on a case by case basis, provided there is a pre-established site specific policy.

### 9.2.2 Initial Inspection

Prior to initial use, all new or modified cranes shall be inspected as required in Section 9.2.6, "Periodic Inspection," by a qualified inspector to ensure compliance with the applicable provisions of this chapter. Dated and signed inspection reports shall be kept on file and shall be readily available.

### 9.2.3 Preoperational Check

a. Operators or other designated personnel shall visually inspect items such as the following each day or prior to use if the crane has not been in regular service (records are not required):

1. All control mechanisms for maladjustment interfering with proper operation.
2. Crane hooks and latches for deformation, cracks, and wear.

3. Hydraulic systems for proper oil level.
4. Lines, tanks, valves, pumps, and other parts of air or hydraulic systems for leakage.
5. Hoist ropes for kinking, crushing, birdcaging, and corrosion.
6. Anti-two-block, two-block warning, and two-block damage prevention systems for proper operation.
7. Booms for damage or deformation of structural components.

b. Operators or other designated personnel shall examine deficiencies and determine whether they constitute a safety hazard.

### 9.2.4 Monthly Inspection

a. The operator or other designated person shall visually inspect the following items for damage, wear, or other deficiency that might reduce capacity or adversely effect the safety of the crane:

1. Critical items such as brakes and crane hooks.
2. Hoist ropes.

b. Lower the hook block to its lowest position and examine for any condition that could result in an appreciable loss of strength.

c. Hooks for cracks, deformation, damage from chemicals, latch engagement (if provided), and evidence of heat damage.

d. A hoist rope with any of the conditions noted in the replacement criteria in Section 9.2.6 shall be removed from service and replaced.

e. Signed and dated inspection records shall be kept on file and shall be readily available.

f. Before the crane is returned to service, correct deficiencies that could reduce its capacity or adversely effect its safety.

### 9.2.5 Frequent Inspection

a. Operators or other designated personnel shall visually inspect the crane at daily to monthly intervals (records are not required).

b. These inspections shall, in addition to the requirements of Section 9.2.3, "Preoperational Check," include the following:

1. All control mechanisms for maladjustment, excessive wear, and contamination by lubricants or other foreign matter that could interfere with proper operation.
  2. All safety devices for malfunction.
  3. Rope reeving for noncompliance with crane manufacturer's recommendations.
  4. Electrical apparatus for malfunctioning, signs of excessive deterioration, and accumulation of dirt or moisture.
  5. Tires for recommended inflation pressure.
  6. Boom sections for damaged, deformed, or missing structural members or parts.
- c. Operators or other designated personnel shall examine deficiencies and determine whether a more detailed inspection is required.

## 9.2.6 Periodic Inspection

- a. Complete inspections of the crane shall be performed by a qualified inspector at 1- to 12-month intervals, depending on the crane's activity, severity of service, and environment.
- b. The qualified inspector shall examine deficiencies and determine whether they constitute a hazard.
- c. Dated and signed inspection records shall be kept on file and shall be readily available.
- d. A sample load test and inspection form is included as Exhibit I, which appears at the end of this chapter. This form is intended to be a sample only and is not intended to be mandatory.
- e. These inspections shall, in addition to the requirements of Sections 9.2.4, "Monthly Inspection," and 9.2.5, "Frequent Inspection," include the following.

### 9.2.6.1 Cranes

Inspect for:

- a. Deformed, cracked, or corroded members in the crane structure and entire boom.

- b. Loose bolts or rivets.
- c. Cracked or worn sheaves and drums.
- d. Hooks damaged from chemicals, deformation, or cracks, or having more than 15 percent in excess of normal throat opening or more than 10 degree twist from the plane of the unbent hook (dye-penetrant, magnetic-particle, or other suitable crack-detecting inspections should be performed at least once a year; see Chapter 13, "Load Hooks," for additional hook requirements).
- e. Worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, and locking devices.
- f. Excessive wear on brake and clutch system parts, linings, pawls, and ratchets.
- g. Load, boom angle, and other operating aids over their full ranges for any significant inaccuracies (if calibration is required, it shall be done by a qualified person).
- h. Gasoline, diesel, electrical, or other power plants for improper performance or noncompliance with safety requirements.
- i. Radiators and oil coolers, for leakage, improper performance, or blockage of air passages.
- j. Excessive wear of chain drive sprockets and excessive chain stretch.
- k. Steering, braking, and locking devices, for malfunctioning.
- l. Excessively worn or damaged tires.
- m. Rust on piston rods and control valves when crane has been idle.

### 9.2.6.2 Hydraulic and Pneumatic Hose, Fittings, and Tubing

Inspect for:

- a. Evidence of leakage at the surface of the flexible hose or its junction with the metal couplings.
- b. Blistering or abnormal deformation of the outer covering of the hydraulic or pneumatic hose.
- c. Leakage at threaded or clamped joints that cannot be eliminated by normal tightening or recommended procedures.

d. Evidence of excessive abrasion or scrubbing on the outer surface of a hose, rigid tube, or fitting (means shall be taken to eliminate the interface of elements in contact or to otherwise protect the components).

### 9.2.6.3 Hydraulic and Pneumatic Pumps and Motors

Inspect for:

- a. Loose bolts or fasteners.
- b. Leaks at joints between sections.
- c. Shaft seal leaks.
- d. Unusual noises or vibration.
- e. Loss of operating speed.
- f. Excessive heating of the fluid.
- g. Loss of pressure.

### 9.2.6.4 Hydraulic and Pneumatic Valves

Inspect for:

- a. Cracks in valve housing.
- b. Improper return of spool to neutral position.
- c. Leaks at spools or joints.
- d. Sticking spools.
- e. Failure of relief valves to attain correct pressure setting (relief valve pressures shall be checked as specified by the manufacturer).

### 9.2.6.5 Hydraulic and Pneumatic Cylinders

Inspect for:

- a. Drifting caused by fluid leaking across the piston.
- b. Rod seal leakage.
- c. Leaks at welded joints.

d. Scored, nicked, or dented cylinder rods.

e. Dented case (barrel).

f. Loose or deformed rod eyes or connecting joints.

### 9.2.6.6 Hydraulic Filters

Evidence of rubber particles on the filter element may indicate deterioration of the hose, "O" ring, or other rubber components. Metal chips or pieces on the filter may denote failure in pumps, motors, or cylinders. Further checking will be necessary to determine the origin of the problem before corrective action can be taken.

### 9.2.6.7 Wire Rope

a. A qualified inspector shall inspect wire ropes at least annually. More frequent intervals shall be determined by a qualified person and shall be based on such factors as expected rope life as determined by severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration, such as described below, that results in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk. This inspection shall include examination of the entire rope length without detaching it from the drum.

1. Reduction of rope size below nominal diameter, whether due to loss of core support, internal or external corrosion, or wear of outside wires (see Table 9-2).

2. The number and distribution or concentration of broken outside wires.

3. Worn outside wires.

4. Corroded or broken wires at end connections.

5. Corroded, cracked, bent, worn, or improperly applied end connections.

6. Kinking, crushing, cutting, or unstranding.

**Table 9-2. Maximum allowable rope reductions.**

Rope diameter	Maximum allowable reduction from nominal diameter
Up to 5/16 in. (8 mm)	1/64 in. (0.4 mm)
Over 5/16 in. to 1/2 in. (13 mm)	1/32 in. (0.8 mm)
Over 1/2 in. to 3/4 in. (19 mm)	3/64 in. (1.2 mm)
Over 3/4 in. to 1 1/8 in. (29 mm)	1/16 in. (1.6 mm)
Over 1 1/8 in. to 1 1/2 in. (38 mm)	3/32 in. (2.4 mm)

b. The qualified inspector shall take care when inspecting running rope where rapid deterioration could occur, such as in the following:

1. Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.

2. Sections of the rope at or near terminal ends where corroded or broken wires may protrude.

c. The qualified inspector shall take care when inspecting certain ropes such as the following:

1. Rotation-resistant ropes, because of their higher susceptibility to damage. The internal deterioration of rotation-resistant ropes may not be readily observable.

2. Boom hoist ropes, because of the difficulties of inspection and the important nature of these ropes.

d. No precise rules can be given for determining the exact time to replace wire rope because many factors are involved. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

e. Conditions such as the following shall be sufficient reason for questioning wire-rope safety and for considering replacement:

1. In running ropes, 6 randomly distributed broken wires in one rope lay, or 3 broken wires in one strand in one rope lay.

2. In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

3. In rotation resistant ropes, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.

4. One outer wire broken at the point of contact with the core of the rope that has worked its way out of the rope structure and protrudes or loops out from the rope structure; additional inspection of this part of the rope is required.

5. Wear of one-third the original diameter of outside individual wires.

6. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.

7. Evidence of heat damage from any cause.

8. Reduction from nominal diameter greater than the amounts listed in Table 9-2.

f. All rope that has been idle for a month or more due to shutdown or storage of a crane on which it is installed shall be inspected before it is placed in service. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required before further use of the rope. A written and dated report of the rope condition shall be filed.

g. In order to establish data as a basis for judging the proper time for replacement, a continuing inspection record shall be maintained.

h. Replacement rope shall be the same size, grade, and construction as recommended by the crane manufacturer, unless otherwise recommended by a rope or crane manufacturer due to actual working-condition requirements.

i. Never use discarded wire rope for slings.

## 9.2.7 Load Hooks/Load Blocks

Load hooks/load blocks that have been changed out shall be inspected by a qualified inspector

before returning the crane to service. Inspection records shall be retained throughout the service life of the hook or load block and shall be readily available.

### **9.2.8 Cranes Not in Regular Use**

a. A crane that has been idle for 1 month or more but less than 6 months shall be given an inspection according to the requirements of Section 9.2.5 before being placed in service.

b. A crane that has been idle for more than 6 months shall be given a complete inspection according to the requirements of Section 9.2.6 before being placed in service.

c. Standby cranes shall be inspected at least semiannually, according to the requirements of Section 9.2.6. Cranes exposed to adverse environments should be inspected more frequently.

## 9.3 TESTING

### 9.3.1 Operational Tests

The following shall be tested during an initial test:

- a. Load lifting and lowering mechanisms.
- b. Boom lifting and lowering mechanisms.
- c. Boom extension and retraction mechanism.
- d. Swinging mechanism.
- e. Travel mechanism.
- f. Safety devices.

### 9.3.2 Rated Load Test

a. Prior to initial use, all cranes in which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector. A designated or authorized

person shall determine if repairs made to a crane are extensive and require a rated load test, or if repairs are routine maintenance and require only operational testing. The replacement of rope is excluded from this requirement. However, a functional test of the crane under a normal operating load should be made prior to putting it back in service.

b. Test weights shall not exceed 110 percent of the rated capacity and shall be accurate to within -5 percent, +0 percent of stipulated values.

NOTE: Load tests shall not be conducted in locations where the lift meets the definition of a critical lift (see Chapter 1, "Terminology and Definitions").

c. A written report shall be furnished by the inspector showing test procedures and confirming the adequacy of repairs or alterations. Test reports shall be kept on file and shall be readily available to appointed personnel.

## 9.4 MAINTENANCE

### 9.4.1 Preventive Maintenance

- a. A preventive maintenance program based on the crane manufacturer's recommendations should be established. Dated records should be made available.
- b. Replacement parts shall be at least equal to the original manufacturer's specifications.
- c. All moving parts of the crane for which lubrication is specified shall be regularly lubricated. Lubricating systems should be checked for proper delivery of lubricant. Operators and maintenance personnel shall follow the manufacturer's recommendations as to the points and frequency of lubrication, maintenance of lubricant levels, and types of lubricant to be used.

### 9.4.2 Maintenance Procedures

- a. Before starting adjustments or repairs on a crane, maintenance personnel shall take the following precautions as applicable:
  1. Place the crane where it will cause the least interference with other equipment or operations in the area.
  2. Lower the lower load block to the ground or otherwise secure it against dropping.
  3. Lower the boom to the ground, if possible, or otherwise secure it against dropping.
  4. Place all controls in the OFF position and secure all operating features from inadvertent motion by brakes, pawls, or other means.
  5. Ensure starting means are rendered inoperative.
  6. Stop the power plant or disconnect it at the power takeoff.
  7. Relieve hydraulic oil pressure from all hydraulic circuits before loosening or removing hydraulic components.
- b. Warning or out-of-order signs shall be placed on the crane controls. Signs or flags shall be removed only by authorized personnel.
- c. After adjustments and repairs have been made, the crane shall not be returned to service

until all guards have been reinstalled, trapped air has been removed from the hydraulic system, safety devices are reactivated, and maintenance equipment is removed.

- d. For locomotive cranes:
  1. Employ blue flag protection on each side of the crane (except dead ends).
  2. Place derails not less than 50 ft from the crane on each side (except dead ends).
  3. Allow only authorized personnel to remove warning signs, flags, and derails.

### 9.4.3 Wire-Rope Maintenance

Personnel using wire rope shall ensure proper care by doing the following:

- a. Store rope to prevent damage or deterioration.
- b. Unreel or uncoil rope as recommended by the rope manufacturer and with care to avoid kinking or inducing a twist.
- c. Before cutting a rope, place seizings on each side of the place where the rope is to be cut to prevent unlaying of the strands. Flame-cutting wire rope is prohibited.
- d. During installation, avoid dragging the rope in the dirt or around objects which will scrape, nick, crush, or induce sharp bends in it.
- e. Maintain rope in a well-lubricated condition to reduce internal friction and to prevent corrosion. Ensure that lubricant applied as part of a maintenance program is compatible with the original lubricant. Consult the rope manufacturer when in doubt. Lubricant applied shall be of the type that does not hinder visual inspection. Those sections of rope that operate over sheaves or are otherwise hidden during inspection and maintenance procedures require special attention when the rope is lubricated.
- f. When an operating rope shows greater wear at its ends than on the remainder, its life can be extended (in cases where a reduced rope length is adequate) by cutting off the worn end, thus shifting the wear to different areas of the rope.

## 9.5 OPERATION

- a. The following shall apply to all personnel involved in mobile crane operation.
- b. At the initial stage of the planning process, an appointed person shall classify each lift into one of the DOE-specified lift categories (ordinary, critical, or preengineered production).

### 9.5.1 Conduct of Operator

- a. Do not engage in any practice that will divert your attention while operating the crane.
- b. Do not operate the crane if you do not meet the requirements contained in Chapter 6 or if you are experiencing a condition resulting in reduced physical or mental capabilities.
- c. Keep the operating area free of water, snow, ice, oil, and debris that could cause your hands or feet to slip from the controls.
- d. Keep the operating cab windshields clean and free of anything that obstructs vision. Replace broken windows.
- e. Ensure proper functioning of tires, horn, lights, battery, controller, lift system (including load-engaging means, chains, hoist rope, and limit switches), brakes, and steering mechanisms. If at any time a lifting device is found to be in need of repair, is defective, or is in any way unsafe, report it immediately to the designated authority and take the unit out of service until it has been restored to safe-operating condition or a determination has been made by the responsible manager that the deficiency will not adversely affect the safe operation of the unit.
- f. When two or more cranes are used to lift one load, one designated person shall be responsible for the operation. That person shall analyze the operation and instruct all personnel involved in the proper positioning, rigging of the load, and the movements to be made. That person shall also determine the necessity to reduce crane ratings, position of load, boom location, ground support, and speed of movement.
- g. Determine that no one is working on the crane or is close to it before starting the engine or beginning to operate the crane.
- h. Barricade accessible areas within the swing radius of the rear of the rotating superstructure of the crane to prevent anyone from being struck or crushed by the crane.
- i. Do not hoist two or more separately rigged loads in one lift, even though the combined load is within the crane's rated capacity.
- j. When fueling the crane, stop the engine(s) and ensure that smoking or open flames are not permitted within 25 ft of the fueling area.
- k. Ensure that a 10BC or larger fire extinguisher is installed at all operator stations. Fire extinguishers shall be maintained in a serviceable condition.
- l. Do not store gasoline, acids, caustics, or cleaning solvents that emit toxic fumes in operating cabs. Store fuel in safety cans in safe locations.
- m. Ensure that alternate egress routes are not locked on mobile units with operating enclosures.
- n. Position the crane on a solid and level footing. It may be necessary in certain situations to use heavy timber mats to build a good working foundation.
- o. When swinging the crane, watch out for centrifugal force. Swing the crane slowly to avoid an outward swing of the load. Attach a tag-line to the load if necessary to control the swing.
- p. Watch for boom kickback. Never operate with the boom at a higher angle than shown on the capacity charts.
- q. Use extreme caution when operating the crane near workers in elevated areas.
- r. Use power lowering when lowering loads. When lowering heavy loads, keep the hoist brake as reserve. Use a safety pawl on the boom-hoist drum when not lowering.
- s. Avoid two-blocking, caused when the hook block makes contact with boom-point sheaves. A continuing pull on the hoist lines can break the rope or pull the boom back over the cab on some types of booms. On hydraulically telescoping booms, be sure to play out the hoist line when extending and spool in the hoist line when retracting.

t. Lock carrier air brakes ON when operating, and check the pressure of the air brakes frequently.

u. Watch out for the carrier-cab on truck-mounted units when swinging the boom. Keep boom high enough to swing clear of cab.

### 9.5.1.1 Traveling the Machine

When traveling the machine:

- a. Secure the boom and hook block.
- b. Check bridges before crossing; make sure they will support the weight of the machine.
- c. Check river depths before fording.
- d. Check clearances under overpasses, overhead lines, or any overhead obstruction; when side clearances are tight, install a barrier or post a lookout, and make certain there is sufficient clearance for tail swing.
- e. When traveling with a load, snub the load to prevent swaying if possible; never travel with near-capacity loads.
- f. Never travel a rubber-tired unit with a load over the side.
- g. On soft surfaces, always move with the load behind; it helps to raise the leading end of the crawlers and makes traveling safer.
- h. Always set swing brakes when the unit is idle or holding loads for a period of time, especially on slopes; if swinging during travel is necessary, engage swing-jaw clutch before releasing brakes.
- i. Never back up until it is determined that everyone is clear of the machine.
- j. Position the boom in the direction of travel for long moves.
- k. Block treads when moving uphill; be sure they are blocked to prevent downhill movement before shifting steering clutches.
- l. Lock the turntable before traveling on a highway. Use a house lock or swing brake, and lower boom into the rack to prevent swing.
- m. When loading machine on the trailer, always use a ramp; if a ramp is not available, use blocking to build one.

### 9.5.1.2 Making Adjustments or Repairs

- a. When making adjustments or repairs:
    1. Stop the machine.
    2. Lower the boom or secure it against dropping.
    3. Neutralize all controls.
    4. Lock starter and remove ignition key to make the machine inoperative.
    5. Display proper warning signs on controls of machine.
    6. Keep hands, feet, and clothing away from gears, ropes, drums, and sheaves.
    7. Never put hands on wire rope when climbing to the top of the cab.
    8. Use a bar or stick to guide wire rope onto drums.
    9. Keep hands well away from the fan drive while engine is running.
    10. Safeguard the crane oiler; do not resume operation until a positive ALL CLEAR signal has been given.
    11. Replace all guards and shields before resuming operation.
  - b. Place blocking or other adequate supports under the boom before beginning boom disassembly operations. Never stand under or on the boom during this work.
  - c. Before disconnecting oil lines, if machine has hydraulic controls, be sure to place boom on the ground or in the boom rest; then move the pedals and control levers to equalize pressures within the cylinders. Always release any air supercharge on the hydraulic reservoir and shut off the engine (or declutch pumps) before disconnecting oil lines.
  - d. Do not reach into hydraulic-boom holes unless the sections are securely anchored together.
- ### 9.5.1.3 Ensuring Stability
- a. Know the rated capacity of the crane and the weight of the load. A safe lift depends on many factors including boom length, boom angle, and

load radius. Follow these requirements to avoid buckling the boom or tipping:

1. Know the radius of the load; the radius is measured from center of rotation, not from the boom foot pin.
  2. Always operate within the rated capacity of the machine.
  3. The gross capacity includes weight of hook, block, and any material-handling devices, (i.e., slings, concrete bucket, magnet lifter, etc.); subtract the weight of all these to find the true weight (net capacity) the crane can handle safely.
  4. Ratings are based on operating the machine on firm, level ground; outriggers should be properly extended and lowered before operation.
  5. Avoid fast swings, hoists, or sudden braking; these can cause overloads.
  6. Do not handle large, heavy loads in strong winds; the wind can catch the load and create an unstable condition.
- b. Test stability before lifting heavy loads. Check outrigger footing. Lift load slightly off the ground and stop. Check the machine for movement and check to be sure the brakes hold with the load elevated.
  - c. Never use machine stability to determine capacity.
  - d. If there are any indications of tipping, the machine is already overloaded for that working radius.
  - e. Do not back crane away from the load while carrying a maximum load; this may cause the crane to tip.
  - f. Always use outriggers when making lifts (with pick-and-carry units), and never lift a load forward of the front outriggers, unless allowed on manufacturer's load chart.
  - g. Lower outrigger jacks until the tires clear the ground, and level the unit to reach the machine's full capacity. Recheck and, if necessary, reset outriggers between heavy lifts.
  - h. Always fully extend outrigger beams unless otherwise specified on the manufacturer's load charts for the crane.

#### 9.5.1.4 Observing Boom-Length Precautions

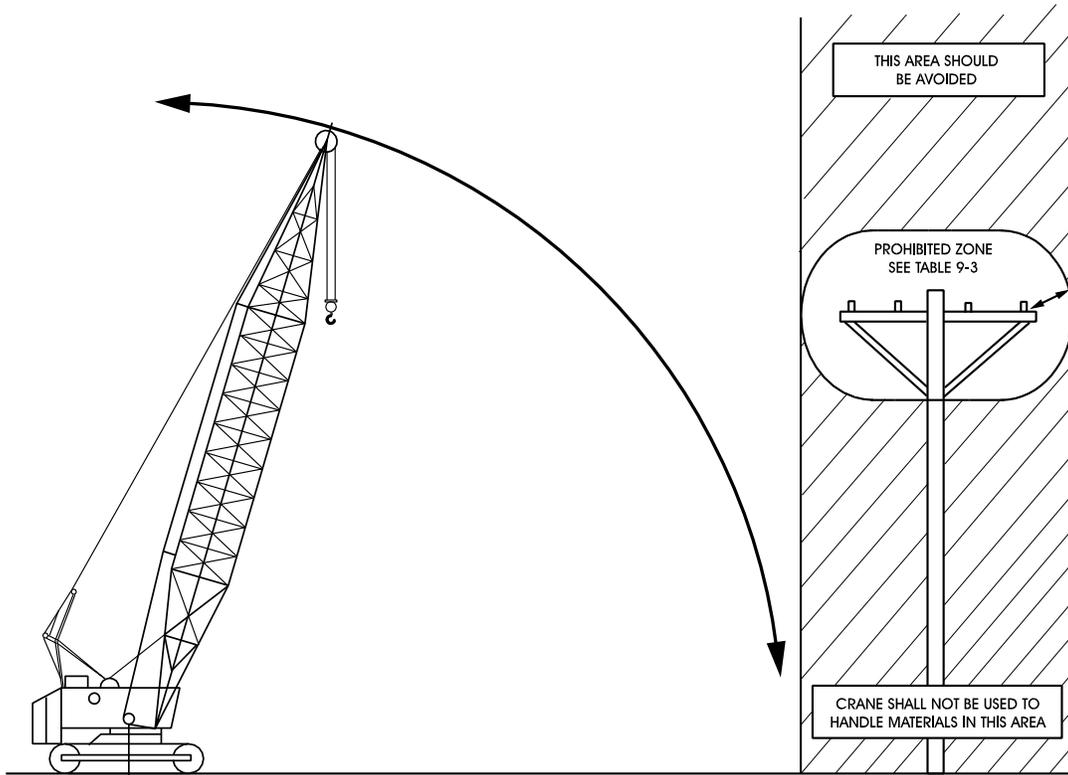
- a. Always use the shortest boom possible.
- b. Make only vertical lifts; never pull the load sideways.
- c. Keep speed slow in lifting and lowering loads.
- d. Swing carefully and slowly, and avoid boom or jib "whipping"; check counterbalance clearance.
- e. Do not let the load strike the boom or outriggers.
- f. Allow maximum clearance between the hook block and boom-point sheaves.
- g. Keep near-capacity loads as close to the ground as possible.
- h. Avoid hitting anything with the boom; an engineering analysis shall be made before putting the crane back in service if this occurs.

#### 9.5.2 Operating Near Power Lines and Transmitter Towers

It is recognized that operating mobile cranes where they can become electrified from electric power lines is an extremely hazardous practice. It is advisable to perform the work so there is no possibility of the crane, load line, or load becoming a conductive path, (Figure 9-2).

The following steps shall be taken to minimize the hazard of electrocution or serious injury as a result of contact between the energized power lines and the crane, load line, or load:

- a. The (electric) Power Marketing Administrations in DOE may deviate from the requirements of Table 9-3, providing the work is done according to line management-approved procedures that do not conflict with statutory regulations or approved variances from these regulations.
- b. Any overhead wire shall be considered to be an energized line unless and until the person owning the line or the electrical utility authorities indicate that it is not an energized line.



**Figure 9-2. Danger zone for cranes and lifted loads operating near electrical transmission line**

**Table 9-3. Safe working distance from power lines.**

a. When operating near high-voltage power lines:				
Normal voltage (phase to phase)				Minimum required clearance
		to	50 kV	10 ft ( 3.1 m)
Over	50	to	200 kV	15 ft ( 4.6 m)
Over	200	to	350 kV	20 ft ( 6.1 m)
Over	350	to	500 kV	25 ft ( 7.6 m)
Over	500	to	750 kV	35 ft (10.7 m)
Over	750	to	1000 kV	45 ft (13.7 m)

b. While in transit with no load and boom or mast lowered:				
Normal voltage (phase to phase)				Minimum required clearance
		to	0.75 kV	4 ft (1.2 m)
Over	0.75	to	50 kV	6 ft (1.3 m)
Over	50	to	345 kV	10 ft (3.5 m)
Over	345	to	700 kV	16 ft (4.9 m)
Over	750	to	1000 kV	20 ft (6.1 m)

c. Durable signs shall be installed at the operator's station and on the outside of the crane, warning that electrocution or serious bodily injury may occur unless a minimum clearance of 10 ft (3.1 m) is maintained between the crane or the load being handled and energized power lines. Greater clearances are required because of higher voltage as stated in Table 9-3. These signs shall be revised but not removed when a local jurisdiction requires greater clearances.

d. Exercise caution when working near overhead lines having long spans as they tend to move laterally or vertically due to the wind, which could cause them to breach the safety zone.

e. Cranes shall not be used to handle materials stored under electric power lines unless any combination of the boom, load, load line, or machine component cannot enter the prohibited zone.

f. Crane operators shall not rely on the coverings of wires for their protection.

#### **9.5.2.1 Crane Operation Near De-energized and Grounded Electric Power Lines**

This is the preferred condition under which the operation can be performed safely. The hazard of injury or death due to electrocution has been removed. The following steps shall be taken to assure de-energization of the power lines has occurred:

a. The power company or owner of the power lines shall de-energize the lines.

b. The lines shall be visibly grounded to avoid electrical feedback and appropriately marked at the job-site location.

c. A qualified representative of the owner of the lines or a designated representative of the electrical utility shall be on site to verify that steps (a) and (b) have been completed and that the lines are not energized.

#### **9.5.2.2 Power Lines Energized, Crane Operating Less than Erected/Fully Extended Boom Length away from the Prohibited Zone (see Figure 9-3)**

a. An on-site meeting between project management and a qualified representative of the owner of the lines or a designated representative

of the electrical utility shall take place to establish the procedures to safely complete the operations.

b. The specified clearance between the power lines and the crane, load line, and load shall be maintained at all times as specified in Table 9-3.

c. Load control, when required, shall utilize tag lines of a non-conductive type.

d. A designated signaler, whose sole responsibility is to verify that the required clearance is maintained shall be in constant contact with the crane operator.

e. No one shall be permitted to touch the crane or the load unless the designated signaler indicates it is safe to do so.

f. Operation of boom and load over electric power lines is extremely dangerous, due to perception of distance and multiple contact points as viewed from the position of the operator and/or position of the designated signaler. The operator should avoid operating the crane, with or without a load, in this area.

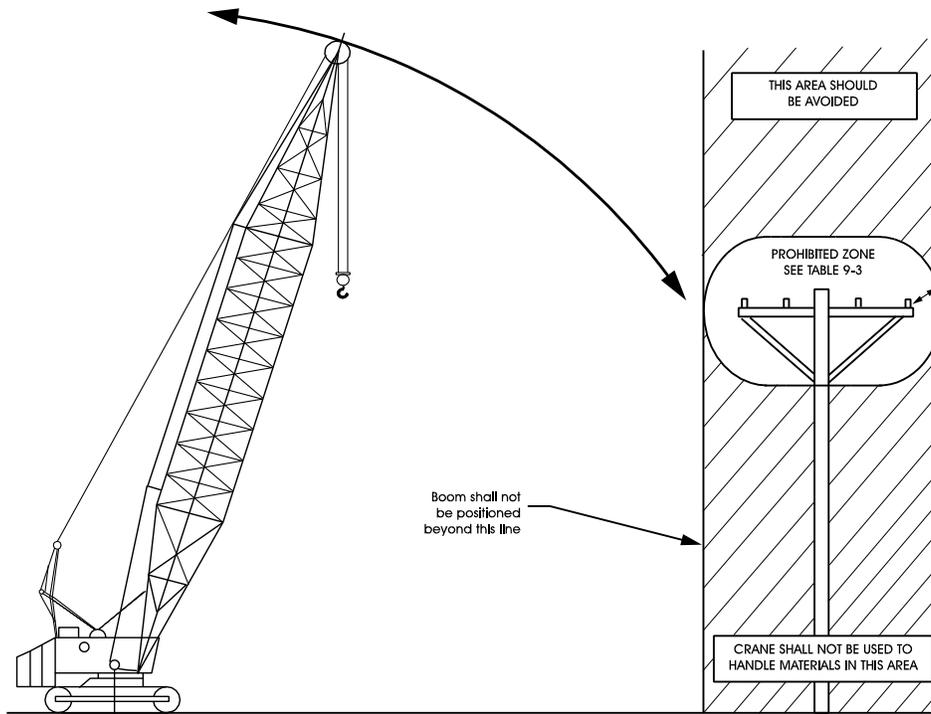
g. The horizontal and vertical distance of movement of long span lines due to the wind shall be added to the minimum clearance distance as specified in Table 9-3. A qualified representative of the owner of the lines or a designated representative of the electrical utility shall be consulted for specific distances.

h. Devices such as ribbons, balls, etc., should be attached by a qualified person to the power lines to improve visibility, or equivalent means employed to aid in location of the prohibited zone.

#### **9.5.2.3 Crane Operations are Within the Prohibited Zone and the Power Lines are Energized**

a. Before such operations take place, a qualified person together with a qualified representative of the utility or an engineer qualified in power line transmission shall, after visiting the site, determine if this is the most feasible way to complete the operation, and set minimum required clearances and procedures for safe operations. These operations shall be under their supervision.

The following guidelines should be required:



**Figure 9-3. Danger zone for cranes and lifted loads operating near electrical transmission line.**

1. Crane/load grounded to a neutral line by the utility.

2. Electrical system protective devices that automatically re-energize the circuit after a power line contact occurrence should be blocked or disengaged to inhibit this function.

3. Insulated barriers, which are not a part of nor an attachment to the crane and which will not allow contact between the energized electric power lines and the crane, load lines, or load.

4. Non-conductive barricades to restrict access to the crane work area.

b. Load control, when required, shall utilize tag lines of a non-conductive type.

c. A designated signaler, whose sole responsibility is to verify that the clearances established are maintained, shall be in constant contact with the crane operator.

d. The person responsible for the operation shall alert and warn the crane operator and all persons working around or near the crane about hazard of electrocution or serious injury and instruct them on how to avoid the hazard.

e. All non-essential personnel shall be removed from the crane work area.

f. No one shall be permitted to touch the crane or the load unless the signaler indicates it is safe to do so.

#### **9.5.2.4 Crane in Transit With No Load and Boom Lowered (see Figure 9-4)**

a. Cranes in transit with no load and boom lowered shall maintain clearance as specified in Table 9-3.

b. A designated signaler shall be assigned to observe the clearance and give warning before the crane approaches the above limits.

c. When planning transit of the crane, the effect of speed and terrain on the boom and crane movement shall be considered.

#### **9.5.2.5 Crane Operation Near Transmitter Towers (see Figure 9-5)**

a. Prior to work near transmitter towers where an electrical charge can be induced in the

equipment or materials being handled, the transmitter shall be deenergized or tests shall be made to determine if electrical charge is induced on the crane. The following precautions shall be taken when necessary to dissipate induced voltages:

1. The equipment shall be provided with an electrical ground directly to the upper rotating structure supporting the boom.

2. Ground jumper cables shall be attached to materials being handled by boom equipment when electrical charge is induced while working near energized transmitters; crews shall be provided with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load.

3. Combustible and flammable materials shall be removed from the immediate area prior to operations.

### **9.5.3 Hoist-Limit Switch**

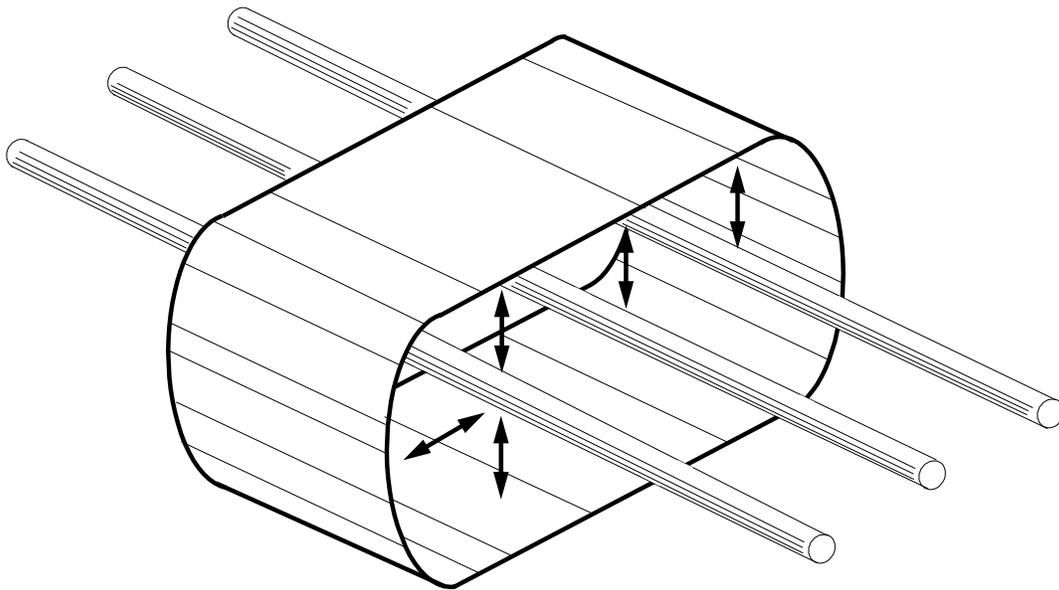
Check all limit switches, if supplied, without a load on the hook at the beginning of each work shift or the first time the crane is used that shift. Inch each motion into its limit switch to ensure that two-blocking does not occur during the test. If a lift is in progress during a shift change, this testing requirement is considered to have been satisfied for the completion of that lift. However, test the limit switch again before the next lift.

### **9.5.4 Standard Hand Signals**

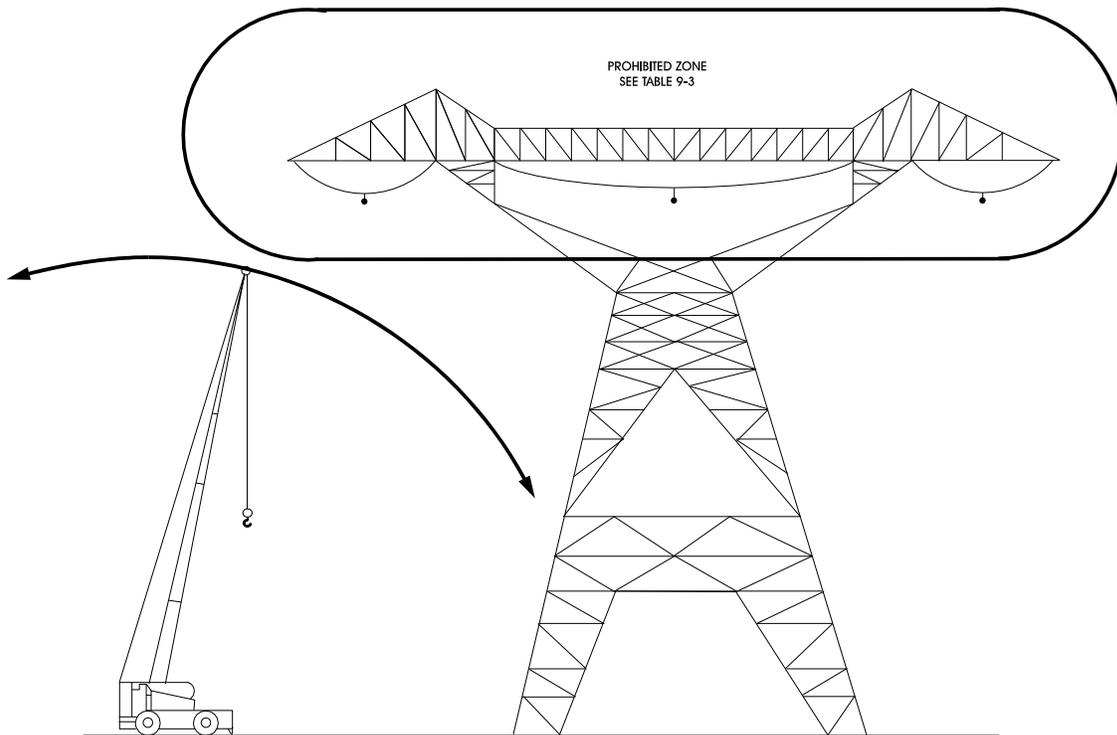
The standard hand signals for DOE use shall be as specified in the latest edition of the ASME B30 standards for the particular type of crane or hoist being used (see Figure 9-6).

### **9.5.5 Identification of Signalers**

a. All personnel acting as signalers during crane operations shall be clearly identified to the crane operator by the use of the following (one or more, as required by the responsible manager): orange hardhat, orange gloves, and orange vest. This requirement may be waived by the responsible manager when the lift is very closely controlled or personnel are required to wear special clothing for protection from a hazardous environment.



**Figure 9-4. Danger zone for cranes and lifted loads operating near electrical transmission line.**  
(See Table 9-3 for minimum radial distance of prohibited zone.)



**Figure 9-5. Danger zone for cranes and lifted loads operating near electrical transmission line.**

b. In those cases where the crane operator cannot see the signaler, a second person (relay signaler) shall be stationed where he or she can see both the signaler and the crane operator and can relay the signals to the operator. The relay signaler shall also be clearly identified by the items described in the previous paragraph.

c. Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator, not through a third person.

d. The operator shall obey signals only from the designated signaler. Obey a STOP signal no matter who gives it.

### 9.5.6 Size of Load

The crane shall not be loaded beyond its rated capacity, except for authorized testing described in Section 9.3.

### 9.5.7 Attaching the Load

a. Ensure that the hoist rope is free from kinks or twists. Do not wrap the hoist rope around the load.

b. Ensure that the load is attached to the load-block hook by means of slings or other approved devices.

c. Take care to make certain that the sling clears all obstacles.

### 9.5.8 Moving the Load

a. The appointed person directing the lift shall make certain that the load is well secured and properly balanced in the sling or lifting device before it is lifted more than a few inches.

b. Before starting to hoist, note the following conditions:

1. Hoist rope shall not be kinked.

2. Multiple-part lines shall not be twisted around each other.

3. The hook shall be positioned above the center of gravity of the load in such a manner as to minimize swinging when the load is lifted.

4. Following any slack-rope condition, it should be determined that the rope is properly seated on the drum and in the sheaves.

5. All personnel including the qualified rigger shall be clear of the load.

c. During hoisting, take care to ensure that:

1. There is no sudden acceleration or deceleration of the moving load.

2. Load does not contact any obstructions. A “dry run” shall be conducted in areas where clearance is limited.

d. Cranes shall not be used for side pulls, except when specifically authorized by a designated person who has determined that the stability of the crane is not endangered and that various parts of the crane will not be overstressed.

e. Avoid carrying loads over people.

f. Test the brakes each time a load approaching the rated capacity is handled by raising the load a few inches and applying the brakes.

g. Do not lower the load below the point where less than two full wraps of rope remain on the hoist drum.

h. Do not leave your position at the controls while the load is suspended, unless required to do so by an approved emergency procedure.

i. Work on suspended loads is prohibited under normal conditions. When the responsible manager decides that it is necessary to work on a suspended load, guidelines for ensuring safety of the work shall be established through consultation with the appropriate safety organization. Suspended loads that must be worked on shall be secured against unwanted movement.

j. Tag lines should be used as required to guide, snub, or otherwise control the load.

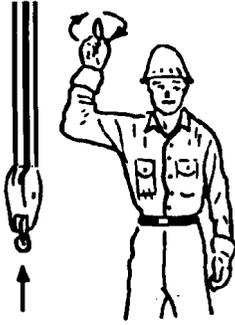
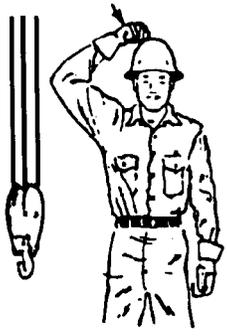
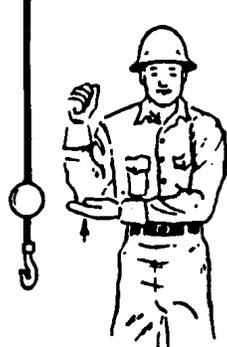
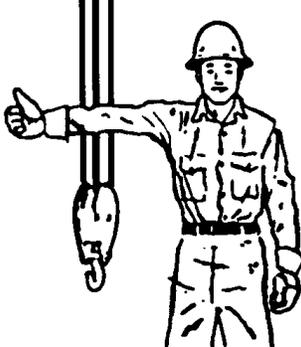
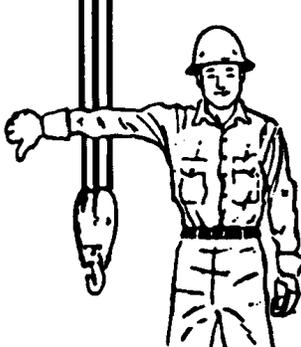
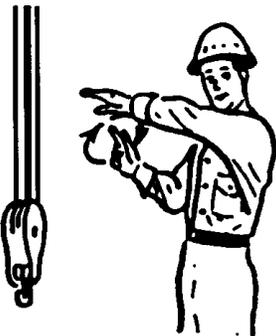
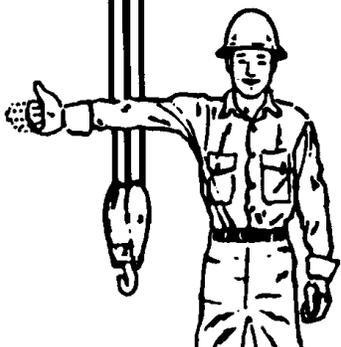
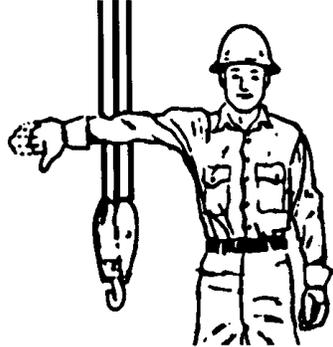
 <p>HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circles.</p>	 <p>LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.</p>	 <p>USE MAIN HOIST. Tap fist on head, then use regular signals.</p>
 <p>USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand, then use regular signals.</p>	 <p>RAISE BOOM. Extend arm, fingers closed, thumb pointing upward.</p>	 <p>LOWER BOOM. Extend arm, fingers closed, thumb pointing downward.</p>
 <p>MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless above the hand giving the motion signal. (Hoist slowly shown as example.)</p>	 <p>RAISE THE BOOM AND LOWER THE LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.</p>	 <p>LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.</p>

Figure 9-6. Standard hand signals for controlling mobile crane operation.

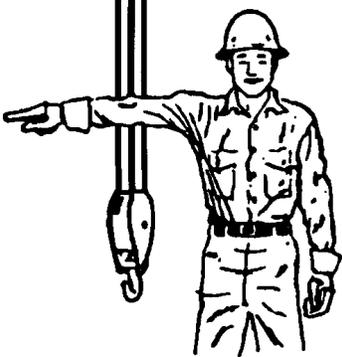
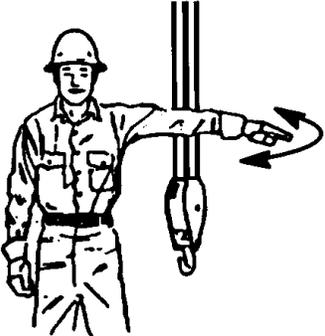
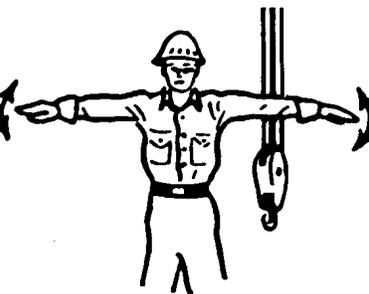
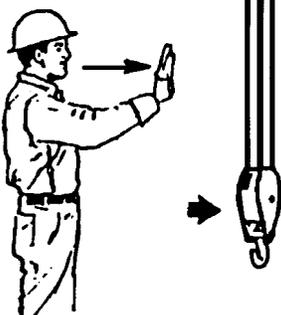
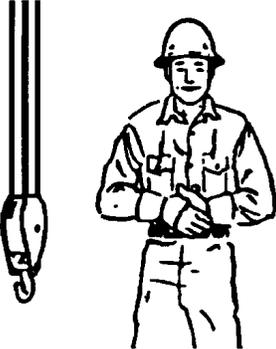
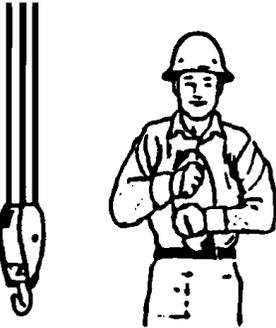
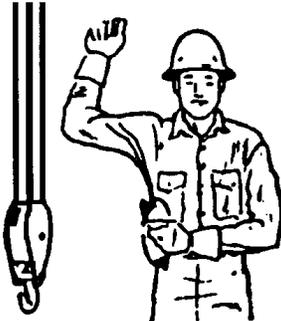
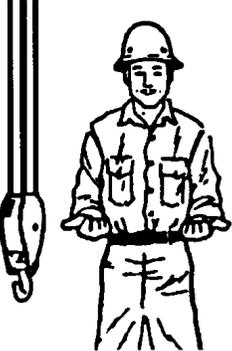
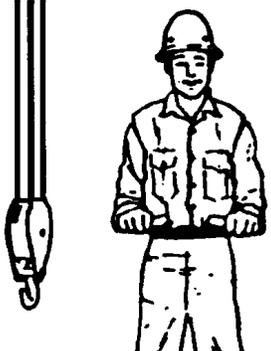
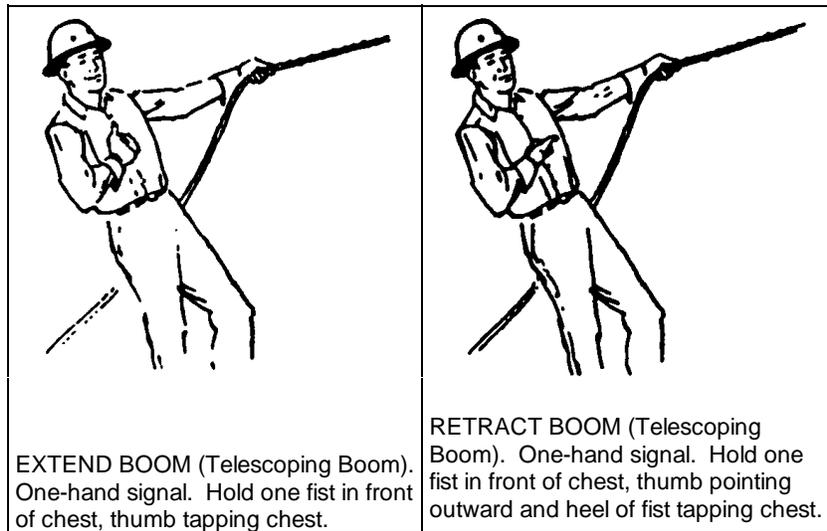
 <p>SWING. Extend arm, point with finger in direction of swing of boom.</p>	 <p>STOP. Extend arm, palm down; move arm back and forth horizontally.</p>	 <p>EMERGENCY STOP. Both arms extended, palms down, move arms back and forth horizontally.</p>
 <p>TRAVEL. Extend arm forward, hand open and slightly raised; make pushing motion in direction of travel.</p>	 <p>DOG EVERYTHING. Clasp hands in front of body.</p>	 <p>TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward (for land cranes only).</p>
 <p>TRAVEL (One Side Track). Lock the track on side indicated by raised fist. Travel opposite track indicated by circular motion of other fist, rotated vertically in front of body (for land cranes only).</p>	 <p>EXTEND BOOM (Telescoping Booms). Hold both fists in front of body, thumbs pointing outward.</p>	 <p>RETRACT BOOM (Telescoping Booms). Hold both fists in front of body, thumbs pointing toward each other.</p>

Figure 9-6. (continued).



**Figure 9-6. (continued).**

### 9.5.9 Ordinary Lifts

a. The requirements of all preceding paragraphs in Section 9.5, "Operation," also shall apply to ordinary lifts.

b. An appointed person shall classify each lift into one of the DOE categories (ordinary, critical or preengineered production) before the lift is planned.

c. Hoisting and rigging operations for ordinary lifts require a designated leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.

d. Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the crew's organizational structure.

e. The designated leader's responsibility shall include the following:

1. Ensure that personnel involved understand how the lift is to be made.
2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.
3. Survey the lift site for hazardous/unsafe conditions.

4. Ensure that equipment is properly set up and positioned.

5. Ensure that a signaler is assigned, if required, and is identified to the operator.

6. Direct the lifting operation to ensure that the lift is completed safely and efficiently.

7. Stop the job when any potentially unsafe condition is recognized.

8. Direct operations if an accident or injury occurs.

f. The designated leader shall inspect all cranes to ensure that they are still within the inspection interval.

g. The designated leader shall inspect all lifting devices to ensure that the rated capacity of these items of equipment will not be exceeded.

h. The operator shall inspect for damage and defects in accordance with Section 9.2.3, including observations during operation. A qualified person shall examine deficiencies and determine whether they constitute a hazard.

i. Check hoist-limit switches, if provided, according to Section 9.5.3, "Hoist-Limit Switch."

j. Ensure that basic operating instructions of power-operated equipment, together with charts,

tables, or diagrams showing the rated capacity, boom angle, swing, and stability data are posted in convenient view of the operator.

k. Check load lines after strain is put on them but before the load is lifted clear of the ground; if load lines are not plumb, reposition the slings or equipment so that the lines are plumb before continuing.

### 9.5.10 Critical Lifts

See Chapter 2, “Critical Lifts,” for critical-lift requirements.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

## EXHIBIT I

MOBILE CRANE LOAD TEST AND INSPECTION

LICENSE OR EQUIPMENT NO. \_\_\_\_\_ MAKE \_\_\_\_\_ DATE \_\_\_\_\_

HOUR METER-ODOMETER TOTAL \_\_\_\_\_ RATED CAPACITY \_\_\_\_\_

LOAD TEST INSPECTION REPORT

The following checklist identifies the items to be inspected prior to the load test. Any unusual conditions observed during the inspection should be noted in the Remarks section. Equipment shall be inspected by maintenance personnel prior to load test.

- NOTES:**
1. Qualified inspector shall verify the inspection is completed.
  2. Craftsmen shall initial and date all tests, work, and inspections completed below.

NO.	CRANE ITEM	DEFECT	OK	NO.	CRANE ITEM	DEFECT	OK
1	Wire Rope			13	Hoist Clutch Lining		
2	Cracked or Worn Sheaves & Drums			14	Hoist Drum Brake Bands		
3	Limit Switch (Anti-Two-Blocking)			15	Open Gears		
4	Boom			16	Boom Jibs (Where Applicable)		
5	Master Clutch			NO.	CARRIER ITEM	DEFECT	OK
6	Steering Clutches			1	Steering Gears and Connections		
7	Hydraulic Pump			2	Brakes (Service and Hand)		
8	Hydraulic Controls			3	Tires and Wheels		
9	Hydraulic Hoses			4	General Lubrication		
10	Mechanical Controls				OPERATING TEST		
11	Drive Chains				OVERALL CONDITION		
12	Swing Clutches						

REMARKS (Unusual conditions—noises, structural cracks, misalignment, etc.)

SAFETY ITEMS: (Fire extinguisher, signs, guards, etc.)

EXHIBIT I (continued)

MOBILE CRANE LOAD TEST AND FOLLOWUP CHECKS

- NOTES:**
1. Craftsman shall initial all steps completed below.
  2. Qualified inspector shall verify all steps below.
    1. Set crane up for load test and inspection.
    2. Perform operations test without load to verify proper function of the following:
      - o Load lifting and lowering mechanisms
      - o Boom lifting and lowering mechanism
      - o Boom extension and retraction mechanisms
      - o Swinging mechanism
      - o Travel mechanism
      - o Safety devices.
    3. Test loads shall not exceed 110% of rated capacity. Refer to load chart for load test capacity at maximum and minimum working radius. Check boom angle indicators for accuracy.
    4. Rig test weights to hook using appropriate slings.
    5. Hoist the test load a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes. Hold the load for 10 min or the time required to check all primary load-bearing parts while under load without slippage, damage, or permanent deformation.
    6. At least once during the lifting portion of the hoisting cycle and once during the lowering cycle, power to the hoisting equipment shall be completely turned off. There shall be no slippage of the load or overheating of the brakes.
    7. Lower the load to approximately 2 in. off the ground to check for swing-roller operation and outrigger stability. Slowly swing test load between outrigger locations.
    8. Move the load back to the original position and slowly lower to ground.
    9. At the completion of the load test, inspect the following:
      - Visually inspect rope in accordance with Section 9.2.6.

MOBILE CRANE LOAD TEST AND FOLLOWUP CHECKS

## DEFECTIVE/OK

- \_\_\_\_\_ a. Rope diameter: (Previous) \_\_\_\_\_ (Present) \_\_\_\_\_
- \_\_\_\_\_ b. Wear
- \_\_\_\_\_ c. Kinks
- \_\_\_\_\_ d. Broken wires
- \_\_\_\_\_ e. Other signs of deterioration.

Visually inspect the rope drum for:

- \_\_\_\_\_ a. Wear
- \_\_\_\_\_ b. Deformation
- \_\_\_\_\_ c. Deterioration
- \_\_\_\_\_ d. Have qualified inspector perform nondestructive tests on hook by visual examination, liquid penetrant examination, or magnetic-particle examination. Acceptance: No cracks, linear indications, laps, or seams.

Hooks with more than 15% normal (new hook) throat opening shall be replaced. Hooks with more than 10 degree twist from the normal (new hook) plane of the hook shall be replaced. Hooks having more than 10% wear in the bowl section or 5% elongation of the shank shall be replaced. Lubricate hook bearing and latch pin, as applicable.

Establish three marks, A, B, and C, with a center punch. For ease in measuring, set distances on an even number of inches.

BEFORE LOAD TEST

Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.

AFTER LOAD TEST

Length AB \_\_\_\_\_ in.

Length BC \_\_\_\_\_ in.

Check for:

1. Wear and deformation
2. Cracks and twisting
3. Signs of opening between Point A and Point B.

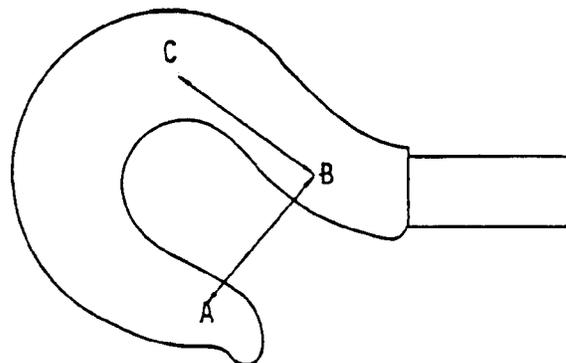


EXHIBIT I (continued)

MOBILE CRANE LOAD TEST AND FOLLOWUP CHECKS

This information should be retained with the equipment.

Record the following:

BLOCK WEIGHT \_\_\_\_\_ lb

TEST WEIGHT \_\_\_\_\_ lb

RADIUS/CENTER PIN TO LOAD \_\_\_\_\_ ft

PARTS LINE \_\_\_\_\_ quantity

BOOM LENGTH \_\_\_\_\_ ft

Load Test Inspection Date \_\_\_\_\_

Qualified Inspector \_\_\_\_\_

Operated By \_\_\_\_\_

# CHAPTER 10

## FORKLIFT TRUCKS

This chapter specifies operation, inspection, testing, and maintenance requirements for forklift trucks powered by internal-combustion engines or electric motors and implements the requirements of ASME B56.1 (“Safety Standard for Powered Industrial Trucks—Low Lift and High Lift Trucks”) and B56.6 (“Rough Terrain Fork Lift Trucks”), and ANSI/UL 558 (“Internal-Combustion-Engine-Powered Industrial Trucks”) and 583 (“Electric-Battery-Powered Industrial Trucks”).

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## 10.1 GENERAL

### 10.1.1 Operator Training/Qualification

Operators of forklift trucks shall be trained and qualified as described in Chapter 6, "Personnel Qualification and Training."

### 10.1.2 Rated Capacity

a. Rated capacity is the maximum weight the truck can transport and stack at a specified load center and for a specified load elevation. Trucks shall not be used or tested above their rated capacities.

b. Additional details are found in ASME B56.1.

### 10.1.3 Marking

Every truck shall have appended to it a durable, corrosion-resistant nameplate with the model or serial number and weight legibly inscribed. The serial number shall also be stamped on the frame. The truck must be accepted by a recognized national testing laboratory and the name-plate shall state that. The truck shall meet all other nameplate requirements of ASME B56.1.

### 10.1.4 Warning Devices

a. Every truck shall be equipped with an operator-controlled horn, whistle, gong, or other sound-producing device(s).

b. The using organization shall determine if operating conditions require the truck to be equipped with additional sound-producing or visual (such as lights or blinkers) devices, and be responsible for providing and maintaining such devices.

NOTE: Backup or motion alarms that sound continuously may be warranted in special cases but are generally less effective than operator-controlled devices.

### 10.1.5 Attachments

a. If the forklift truck is equipped with front-end attachments (other than factory-installed attachments), the rated capacity shall be established by the truck manufacturer at a specified load center and for a specified load elevation.

b. Users shall ensure that the truck is marked to identify the attachments and to show the approximate weight of the truck/attachment combination and the capacity of the truck with attachments at maximum elevation with load centered laterally.

c. The rated capacity of the front-end attachment/forklift truck combination shall not be exceeded.

d. Every removable attachment (excluding fork extensions) shall have a durable corrosion-resistant nameplate installed on it with the following information legibly and permanently inscribed:

1. Model number.
2. Serial number (on hydraulically actuated attachments).
3. Maximum hydraulic pressure (on hydraulically actuated attachments).
4. Weight of attachment.
5. Rated capacity of attachment.
6. The following instruction (or equivalent):
  - i. Capacity of forklift truck/front-end attachment combination may be less than the capacity shown on attachment. Consult forklift truck nameplate.

### 10.1.6 Modifications

Modifications or additions that affect capacity or safe operation shall not be performed without prior written approval from the forklift truck manufacturer. Capacity, operation, and maintenance instruction plates, tags, or decals shall be changed accordingly.

### 10.1.7 Overhead Guards

a. Users shall ensure that high lift rider trucks, including order picker trucks, are equipped with an overhead guard manufactured in accordance with ASME B56.1, unless all of the following conditions are met:

1. Vertical movement of the lifting mechanism is restricted to 72 in. (1800 mm) or less from the ground.
  2. The truck will be operated only in an area where:
    - i. The bottom of the top tiered load is not higher than 72 in. (1800 mm) and the top is not more than 120 in. (3000 mm) from the ground where tiered.
    - ii. Only stable (preferably interlocked, unitized or containerized) loads are handled.
    - iii. There is protection against falling objects from adjacent high stack areas.
  3. The truck is marked to identify where it can be operated.
- b. Rough terrain forklift trucks shall be fitted with an overhead guard manufactured in accordance with ASME B56.6.
- c. An overhead guard is intended to offer protection to the operator from falling objects, but it cannot protect against every possible impact. Therefore, it should not be considered a substitute for good judgement and care in load handling.

### 10.1.8 Fire Hazard Areas

Powered forklift trucks for operation in fire hazard areas shall be of the type recommended in ANSI/NFPA 505 (“Powered Industrial Trucks, Type Designation and Areas of Use”).

### 10.1.9 Work Atmosphere

The operation of forklift trucks affects the concentrations of carbon monoxide and oxygen in the work location. Concentrations of these materials in the work location must meet the requirements of 29 CFR 1910, Occupational Safety and Health Standards for General Industry.

### 10.1.10 Electric-Battery-Operated Trucks

Use of electric-battery-operated trucks is restricted to those trucks that meet the requirements of ANSI/UL 583.

### 10.1.11 Internal-Combustion Trucks

Use of internal-combustion-powered forklift trucks is restricted to those trucks that meet the requirements of ANSI/UL 558.

### 10.1.12 Fork Arm

For forklift trucks purchased after December 1984, each fork arm shall be clearly stamped with its rated capacity in an area readily visible and not subject to wear. For example, the designation 1500 × 24 means 1,500-lb (680-kg) capacity at 24-in. (600-mm) load center.

### 10.1.13 Design Standards

- a. Structural, mechanical, and electrical components shall meet all requirements of ASME B56.1.
- b. The safety features and operation shall conform, at a minimum, to the provisions of ASME B56.1.

## 10.2 TYPE DESIGNATIONS AND AREAS OF USE

### 10.2.1 Type Designation

The following system shall be used as a basis to choose appropriate types of powered forklift trucks for operation in nonhazardous and hazardous locations (see ANSI/NFPA 505).

#### 10.2.1.1 Nonhazardous Locations

NOTE: The following units are not suitable for use in hazardous areas since they include only minimum safeguards against inherent fire hazards.

- a. *Type D Forklifts*—diesel-powered units having minimum acceptable safeguards against inherent fire hazards.
- b. *Type E Forklifts*—electrically powered units having minimum acceptable safeguards against inherent fire and electrical shock hazards.
- c. *Type G Forklifts*—gasoline-powered units having minimum acceptable safeguards against inherent fire hazards.
- d. *Type LP Forklifts*—liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards.
- e. *Type G/LP Forklifts*—gasoline- or liquefied-petroleum-gas-powered units having minimum acceptable safeguards against inherent fire hazards.

#### 10.2.1.2 Hazardous Locations

NOTE: The following units are suitable for use in hazardous areas since they are equipped with additional safeguards (i.e., special exhaust, fuel, or electrical systems) or other modifications against inherent fire hazards.

- a. *Type DS Forklifts*—diesel-powered units that are provided with all the requirements for the type D units and that have additional safeguards to the exhaust, fuel, and electrical systems.
- b. *Type DY Forklifts*—diesel-powered units that have all the safeguards of the type DS units except that they do not have any electrical equipment, including ignition; they are equipped with temperature-limitation features.

c. *Type ES Forklifts*—electrically powered units that are provided with all the requirements for the type E units and that have additional safeguards to the electrical system to prevent emission of hazardous sparks and to limit surface temperatures.

d. *Type EE Forklifts*—electrically powered units that are provided with all the requirements for the type E and ES units, and that also have electric motors and all other electrical equipment completely enclosed.

e. *Type EX Forklifts*—electrically powered units that differ from type E, ES, or EE units in that the electrical fittings and equipment are designed, constructed, and assembled so that the units may be used in atmospheres containing specifically named flammable vapors, dusts, and, under certain conditions, fibers; type EX units are specifically tested and classified for use in Class I, Group D, or for Class II, Group G locations as defined in NFPA 70, the National Electrical Code.

f. *Type GS Forklifts*—gasoline-powered units that, in addition to all the requirements for the type G units, are provided with additional safeguards to the exhaust, fuel, and electrical systems.

g. *Type GS/LPS Forklifts*—gasoline- or liquefied-petroleum-gas-powered units that, in addition to all the requirements for the type G/LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems.

h. *Type LPS Forklifts*—liquefied-petroleum-gas-powered units that, in addition to the requirements for the type LP units, are provided with additional safeguards to the exhaust, fuel, and electrical systems.

### 10.2.2 Specific Areas of Use

- a. The responsible industrial safety organization shall classify the atmosphere or location where the powered forklift is to be used as being hazardous or nonhazardous. Location classifications are described as follows:

1. *Class I*—locations in which flammable gases or vapors are present or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

2. *Class II*—locations that are hazardous because of the presence of combustible dust.

3. *Class III*—locations where easily ignitable fibers or filings are present but are not likely to be suspended in quantities sufficient to produce ignitable mixtures.

4. *Unclassified*—locations not possessing atmospheres defined as Class I, II, or III locations.

b. A qualified person shall select forklift trucks for use in hazardous areas in accordance with the requirements of ANSI/NFPA 505.

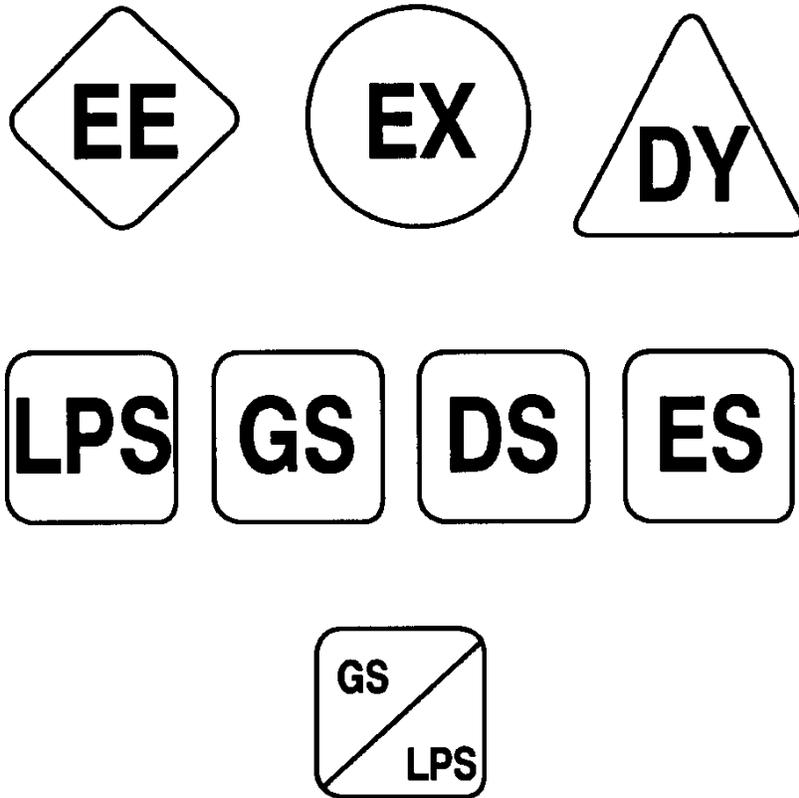
### 10.2.3 Forklift Truck Markers

a. The use of proper equipment in hazardous areas is essential for the safety and protection of personnel and property. Trucks approved for use in hazardous areas shall have the manufacturer's label or some other identifying mark indicating approval for the intended use by a recognized national testing laboratory [e.g., Underwriters Laboratories (UL) or Factory Mutual (FM)].

b. Durable markers indicating the designation of the type of truck for use in hazardous areas shall be applied to each side of the vehicle in a visible but protected area. These markers shall be distinctive in shape, as indicated in Figure 10-1.

### 10.2.4 Hazardous-Area Signs

The entrance to hazardous areas shall be posted with a sign to identify the type of forklift truck permitted. See Figure 10-2.



**NOTE:** The markers for EE, EX, and DY are 5 in. (12.7 cm) high. The rest are 4 in. (10 cm) square. The signs shall have black borders and lettering on a yellow background.

**Figure 10-1. Markers to identify type of industrial truck.**



**NOTE:** The minimum width of the sign is 11 in. (28 cm); the minimum height is 16 in. (40 cm). The sign shall have the word "caution" in yellow letters on a black background. The body of the sign shall have black letters on a yellow background. A marker identical to the one used on the side of the truck as shown in Figure 10-1, shall be installed on the sign.

**Figure 10-2.** Building signs for posting at entrance to hazardous areas.

## 10.3 INSPECTIONS

### 10.3.1 Daily Preoperational Check

Before operating the forklift, the operator shall check for proper condition of the following: horn, lights, battery, tire condition/inflation, brakes, steering mechanism, and operating controls. If at any time a forklift is in need of repair, is defective, or shows any condition that could affect its safety, the condition shall be reported immediately to the designated authority. The unit shall be taken out of service until it has been restored to safe-operating condition.

### 10.3.2 Periodic Inspection Requirements

a. Prior to initial use, all new, modified, or extensively repaired forklifts shall be inspected by a qualified inspector to ensure compliance with the provisions of this chapter.

b. A qualified inspector shall inspect forklifts when they are assigned to service and at least once every 6 months thereafter. A qualified inspector shall nondestructively examine the forks, when required by the manufacture, at 12-month intervals. Inspection records shall be kept on file and shall be readily available. A sample load test and inspection form is included as Exhibit I, which appears at the end of this chapter. This form is intended to be a sample only and is not intended to be mandatory.

c. A qualified inspector shall perform the following during periodic inspections:

1. Inspect brakes, steering mechanisms, control mechanisms, warning devices, lights, governors, lift-overload devices, guards, and safety devices regularly and maintain them in a safe-operating condition.

2. Carefully inspect all parts of lift and tilt mechanisms and frame members and maintain them in a safe-operating condition.

3. For special trucks or devices, designed and approved for operation in hazardous areas, ensure that the original, approved safe-operating features are preserved by maintenance.

4. Check fuel systems for leaks and for the proper condition of the parts. Give special consideration in the case of a fuel system leak. Take action to prevent use of the truck until the leak has been corrected.

5. Inspect all hydraulic systems and maintain them in conformance with good practice. Check tilt cylinders, valves, and other similar parts to ensure that drift or leakage has not developed to the extent that it would create a hazard.

6. Maintain capacity, operation safety, and maintenance-instruction plates, tags, or decals in legible condition.

7. Inspect batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections and maintain them in conformance with good practice. Pay special attention to the condition of electrical insulation.

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## 10.4 TESTING

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a. Prior to initial use, all forklifts in which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector.

1. Test loads shall not exceed 100 percent of the rated capacity.

2. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values.

3. Load slippage shall not be greater than 3 in. vertically and 1 in. horizontally at the cylinder during a static test period of at least 10 min. duration.

4. A written report shall be furnished by the inspector, showing test procedures and confirming the adequacy of repairs or alterations. Test reports shall be kept on file and readily available to appointed personnel.

b. Load tests shall not be conducted above critical items.

## 10.5 OPERATION

The following shall apply to all personnel involved in forklift operations. At the initial stage of the planning process, an appointed person shall classify each lift into one of the DOE-specified categories (ordinary, critical, or preengineered production).

### 10.5.1 Conduct of Operator

- a. Do not engage in any practice that will divert your attention while operating the forklift.
- b. Do not operate the forklift when you are physically or mentally incapacitated.
- c. Keep the operating area free of water, snow, ice, oil, and debris that could cause your hands or feet to slip from the controls.
- d. Give special consideration to the proper functioning of tires, horn, lights, battery, brakes, steering mechanisms, and operating controls. If at any time a forklift needs repair, is defective or in any way unsafe, report the matter immediately to the designated authority. The unit shall be taken out of service until it has been restored to safe-operating condition or a determination has been made by the cognizant manager that the deficiency will not adversely affect the safe operation of the unit.
- e. Ensure that rigging loads from the tines of forklift trucks is performed according to site-specific direction.
- f. Forklift truck operators shall do the following:
  1. Before operation of electrically powered machines, check location of the battery plug for quick disconnection in case of a short circuit.
  2. Avoid sudden stops.
  3. Face in the direction of travel, except as follows:
    - i. For better vision with large loads, operate the truck in reverse gear.
    - ii. When ascending or descending grades in excess of 5 percent, drive loaded rider trucks with the load upgrade.
- iii. Operate unloaded trucks on all grades with the load-engaging means downgrade.
  4. Stop and sound the horn at all blind corners and intersections and when going through doorways.
  5. Operate at safe speeds: in-plant buildings, 5 mph; in-plant roads, 15 mph maximum.
  6. Go around curves slowly.
  7. Use low gear or slowest speed when descending ramps.
  8. Do not allow riders on forklift trucks unless the truck is built with passenger seating.
  9. Know the weight of the load and do not exceed the rated capacity of the truck.
  10. Consider both truck and load weight when traveling in areas where there are floor-loading requirements.
  11. Watch overhead clearance; if in doubt, measure.
  12. Keep clear of edges of loading docks.
  13. Watch rear-end swing.
  14. Before handling them, ensure that stacks and loads are stable; block and lash them if necessary.
  15. Always spread the forks to suit the load width.
  16. Lower and raise the load slowly; make smooth, gradual stops.
  17. Lift and lower loads only while the vehicle is stopped.
  18. Use special care when high-tiering; return the lift to a vertical position before lowering the load.
  19. Lift, lower, and carry loads with the upright vertical or tilted back—never forward; on all grades, the load and load-engaging means shall be tilted back.

20. To avoid injury, keep arms and legs inside the operator's area of the machine.

21. Never travel with forks raised to unnecessary heights; approximately 4 to 6 in. above floor level is adequate.

22. When loading trucks or trailers, ensure that the wheels are chocked and the brakes set; place loads in front end of the semitrailer only if the tractor is attached or adequate trailer (railroad) jacks are in place.

23. Inspect floors on trucks, boxcars, unfamiliar ramps, or platforms before starting operation.

24. Be sure bridge plates into trucks or freight cars are sufficiently wide, strong, and secure; portable and powered dockboards shall be conspicuously marked with carrying capacity.

25. Never butt loads with forks or rear end of truck.

26. Remember that forklift trucks should not be used as tow trucks unless a towing hitch approved by the manufacturer is used.

27. Stop engine before refueling.

28. Use only approved explosion-proof lights to check gas-tank and battery-water levels; smoking is not permitted during this operation.

29. Place forks flat on the floor when the truck is parked.

30. Turn ignition switch to OFF position when leaving the machine.

31. Always set brakes before leaving the truck.

32. Report evidence of faulty truck performance.

33. When exiting or leaving the truck, step down—do not jump.

34. Report all accidents promptly to the supervisor.

35. Use guides and signalers as much as possible; if in doubt, check personally before proceeding; the final responsibility for the handling of a truck remains with the driver.

36. Never lift with one fork without an engineering analysis and approval.

## 10.5.2 Lifting of Personnel

Take the following precautions whenever personnel are elevated with a forklift truck:

a. Use a lift platform manufactured for the purpose of lifting personnel with a forklift truck that meets the requirements of ASME B56.1.

b. Ensure that a restraining means (handrails or chains) exists that is capable of withstanding a force of 200 lb in any direction; if no restraining means is provided, personnel on the platform shall wear a body harness with lanyard or deceleration device.

c. When being supported by a forklift, the personnel platform shall be attached in such a manner that it cannot slide or bounce off the forks.

d. The operator shall remain in the control position of the forklift truck or means shall be provided whereby personnel on the platform can shut power off to the forklift truck.

e. Overhead protection, as indicated necessary by operating conditions, shall be provided.

f. Means shall be provided to protect personnel from moving parts of the forklift truck that present a hazard when the personnel platform is in the normal working position.

g. Do not transport personnel from one location to another while they are on the work platform.

h. Ensure that 4-in. (10-cm) toe boards are provided on the work platform.

i. Whenever a truck (except for high-lift order-picker trucks) is equipped with vertical hoisting controls elevatable with the lifting carriage or forks, take the following additional precautions to protect personnel:

1. Means shall be provided whereby personnel on the platform can shut off power to the truck.

2. Means shall be provided to render inoperative all operating controls, other than those on the elevating platform, when the controls on the elevating platform have been selected for use; only one location of controls shall be capable of being operated at one time.

3. Emergency-lowering means available at ground level should be provided; such means shall be protected against misuse.

### 10.5.3 Standard Hand Signals

a. Standard hand signals for use at DOE locations shall be as specified in the latest edition of the ANSI standards for the particular forklift being used (see Figure 10-3).

b. The operator shall recognize signals only from the designated signaler. *Obey a STOP signal no matter who gives it.*

### 10.5.4 Size of Load

a. Since the load rating for forklifts may be based on stability or hydraulic or structural competence, do not exceed the rated capacity in operational application.

b. Do not load forklifts beyond rated capacity.

c. The designated person shall ensure that the weight of a load approaching the rated capacity (combination of weight and location of the center of gravity) has been determined within -10 percent, +0 percent before it is lifted.

### 10.5.5 Moving the Load

a. The nature of the terrain and the surface on which the truck is to operate are very important factors in the stability of the load-truck system. The designated person shall ensure that a proper truck has been selected to operate on the surface available. In general, small, three-wheeled trucks should operate on smooth, hard surfaces only and are not suitable for outdoor work.

b. The designated person shall ensure that the load is well secured and properly balanced before it is lifted.

c. During hoisting, ensure that:

1. There is no sudden acceleration of the load.

2. The load does not contact any obstruction.

### 10.5.6 Ordinary Lifts

a. The requirements of all preceding paragraphs in Section 10.5, "Operation," shall also apply to ordinary lifts.

b. An appointed person shall classify each lift into one of the DOE categories (ordinary, critical or preengineered production) before the lift is planned.

c. Hoisting and rigging operations for ordinary lifts require a designated leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.

d. Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the crew's organizational structure.e.

The designated leader's responsibility shall include the following:

1. Ensure that personnel involved understand how the lift is to be made.

2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.

3. Survey the lift site for hazardous/unsafe conditions.

4. Ensure that equipment is properly set up and positioned.

5. Ensure that a signaler is assigned, if required, and is identified to the operator.

6. Direct the lifting operation to ensure that the job is done safely and efficiently.

7. Stop the job when any potentially unsafe condition is recognized.

8. Direct operations if an accident or injury occurs.

### 10.5.7 Critical Lifts

See Chapter 2, "Critical Lifts," for critical-lift requirements.

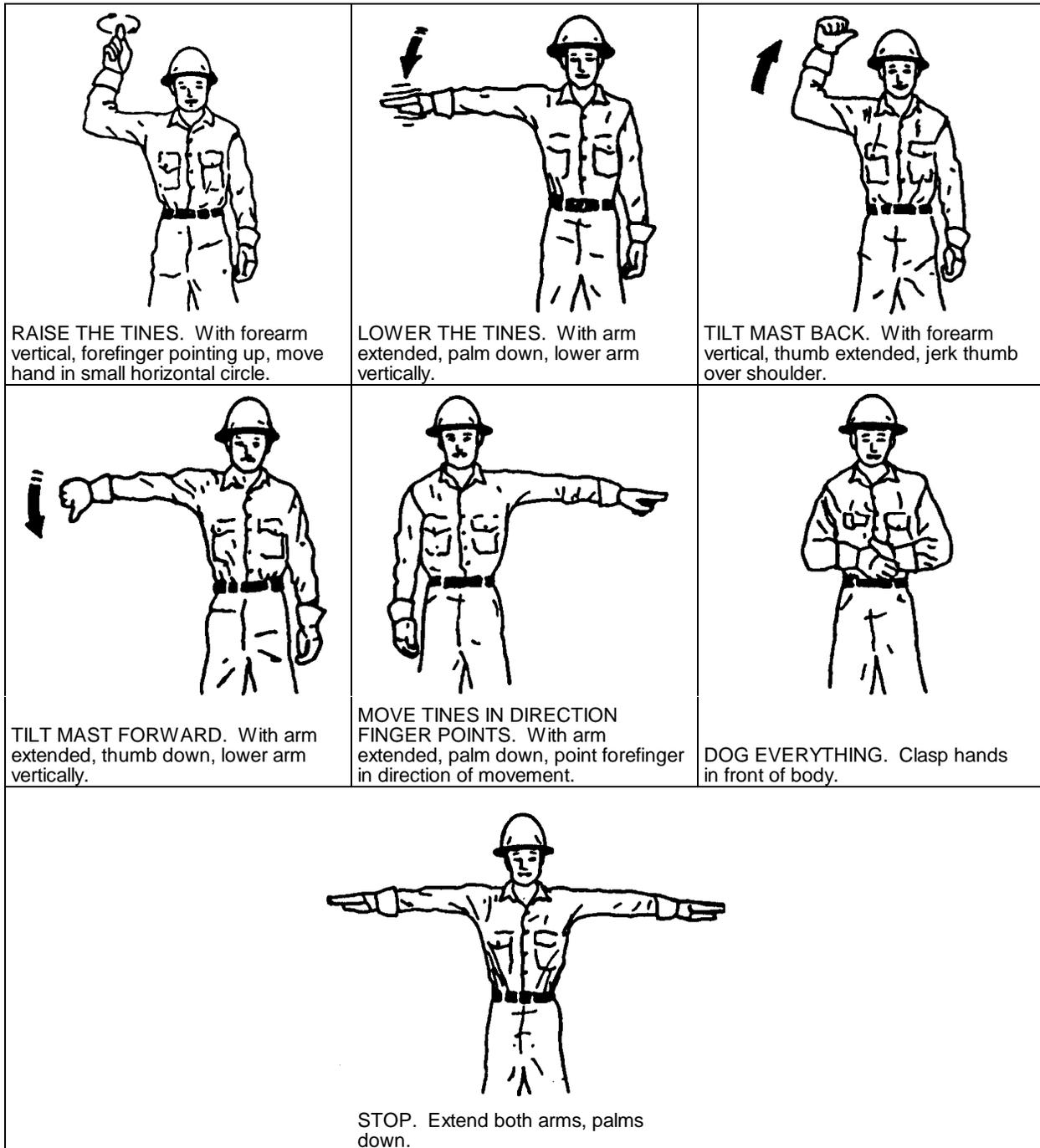


Figure 10-3. Standard hand signals for controlling forklift operation.

Exhibit I is intended to be a sample and is not mandatory. Any other form that accomplishes the purpose is acceptable.

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EXHIBIT

FORKLIFT LOAD TEST AND INSPECTION

INSPECTED BY \_\_\_\_\_ EQUIPMENT NUMBER \_\_\_\_\_

LOCATION \_\_\_\_\_ DATE \_\_\_\_\_

INSPECTION: Forklifts shall be inspected when assigned to service and at least every 6 months thereafter.

Prior to initial use, all new, modified, or extensively repaired forklifts shall be inspected.

Craftsmen shall initial all tests, work, and inspections completed below.

Qualified inspector shall verify inspection complete prior to load test.

CRAFTSMAN  
INITIAL

- \_\_\_\_\_ 1. Ensure capacity, operation, and maintenance-instruction plates, tags, or decals are legible.
- \_\_\_\_\_ 2. Check all hydraulic systems including tilt cylinders, valves, and other similar parts to ensure "drift" has not developed.
- \_\_\_\_\_ 3. Check fuel system for leaks and condition of parts. Special consideration shall be given in the case of a leak in the fuel system. Immediate action shall be taken to take the forklift out of service until the leak is corrected.
- \_\_\_\_\_ 4. Check all parts of lift and tilt mechanisms and frame members to ensure safe operating conditions, such as, but not limited to, hoist chain for damage and excessive wear.
- \_\_\_\_\_ 5. Check for proper tire inflation (where applicable). Check that tires are secured properly and are level with each other.
- \_\_\_\_\_ 6. Check batteries, motors, controllers, limit switches, protective devices, electrical conductors and connections, with special attention paid to the condition of electrical insulation.
- \_\_\_\_\_ 7. Check brakes, steering mechanisms, warning devices, lights, governors, lift overload devices, guards, and safety devices.

Qualified inspector shall use the criteria for Items 8, 9, and 10 to perform visual examination, when required by the manufacture, liquid penetrant examination, or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

- \_\_\_\_\_ 8. Check for forks being secured properly and level with each other.
- \_\_\_\_\_ 9. Nondestructive examination (NDE) inspector performs nondestructive test (NDT) on the right angle joint of the fork once every 12 months.
- \_\_\_\_\_ 10. NDE inspector performs NDT on the load or stress-bearing welds that attach the tines to the forklift once every 12 months.

**EXHIBIT I (continued)**

FORKLIFT LOAD TEST

LOAD TEST

NOTES: 1. Read all steps below prior to load test.

- 2. Forklifts in which load-sustaining parts have been altered, replaced, or repaired shall be load tested prior to initial use.
- 3. Load test all forklifts at 100% rated capacity.

QUALIFIED INSPECTOR: Shall verify all steps below.

EQUIPMENT NUMBER \_\_\_\_\_ EQUIPMENT OPERATOR \_\_\_\_\_

Qualified Inspector Verify (Load Test) \_\_\_\_\_ Date \_\_\_\_\_

Weight \_\_\_\_\_

- 1. Set forklift on solid, level ground.
- 2. Perform load test using the required weight (see Note 3).

Static Test: Forklift trucks shall demonstrate ability to withstand the appropriate test load for a period of at least 10 min without permanent deformation or apparent damage. Load slippage for this equipment shall not be greater than a maximum of 3 in. vertically and 1 in. horizontally at the cylinder.

- 3. Check system for leaks while undergoing test.

# CHAPTER 11

## WIRE ROPE AND SLINGS

This chapter provides requirements for the fabrication and use of wire rope and slings used in hoisting and rigging.

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## 11.1 GENERAL

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- a. The information in this section provides guidance for safely handling lifted loads. Diagrams are used to illustrate hoisting and rigging principles and good and bad rigging practices. This is not a rigging textbook; the information should be applied only by qualified riggers.
- b. Wire rope and slings that have been irreversibly damaged or removed from service shall be made unusable for hoisting and rigging operations before being discarded.
- c. Load tables are representative only and are not exact for all materials or all manufacturers.
- d. Determine the weight of the load:
1. From markings on the load.
  2. By weighing, if the load is still on a truck or railroad car.
  3. From drawings or other documentation.
  4. By calculation, using the load dimensions and the weights of common materials in Table 11-1.
- e. Determine the center of gravity of the load as accurately as possible:
1. From drawings or other documentation.
  2. From markings on the load.
  3. By calculation.
- f. Determine the best method to attach the load and select the appropriate lifting devices (e.g., wire-rope, steel-chain, metal-mesh, or synthetic-web slings).
- g. Bending a wire rope over a fixed object such as a pin or a shackle has an effect on the capacity of the rope: the outside wires and strands of a bend have to stretch farther and therefore take a greater percentage of the load.
- h. There is a convenient method for estimating the efficiency of the rope as it passes over the bend. This method uses the ratio (R) of the diameter (D) of the object (sheave, pin, corner) about which the wire rope is being bent to the diameter (d) of the rope. The efficiency of the bend can then be estimated using the formula shown in Figure 11-1. Note that the efficiency decreases quickly as the ratio of the diameters decreases.
- i. Aside from efficiency, there are other reasons to avoid sharp bends in wire rope, including physical damage to the rope, reduction of service life, and damage to the object about which the rope is bent.
- j. When the ratio of the diameter of the bend to the nominal rope diameter (D/d ratio) is small, the strength efficiency factor is lower than when the D/d ratio is relatively large. Load tables do not take into account such factors as abnormal temperatures, excessive corrosion, and vibration.
- k. Determine the appropriate ratings of the device to be used, allowing for:
1. *The number of sling legs*—Note that a sling leg completely doubled back on itself constitutes two sling legs.
  2. *The angle between the horizontal surface of the load and the sling leg*—The smaller the angle, the smaller the lifting capacity of the equipment.
  3. *Wear*—The reduction in strength of the equipment due to normal wear.

**Table 11-1. Weights of common materials.**

Name of metal	Weight (lb/ft <sup>3</sup> )	Name of material	Weight (lb/ft <sup>3</sup> )
Aluminum	166	Bluestone	160
Antimony	418	Brick, pressed	150
Bismuth	613	Brick, common	125
Brass, cast	504	Cement, Portland (packed)	100–120
Brass, rolled	523	Cement, Portland (loose)	70–90
Copper, cast	550	Cement, slag (packed)	80–100
Copper, rolled	555	Cement, slag (loose)	55–75
Gold, 24-carat	1,204	Chalk	156
Iron, cast	450	Charcoal	15–34
Iron, wrought	480	Cinder concrete	110
Lead, commercial	712	Clay, ordinary	120–150
Mercury, 60 degrees F	846	Coal, hard, solid	93.5
Silver	655	Coal, hard, broken	54
Steel	490	Coal, soft, solid	84
Tin, cast	458	Coal, soft, broken	54
Uranium	1,163	Coke, loose	23–32
Zinc	437	Concrete or stone	140–155
<u>Name of wood</u>		Earth, rammed	90–100
Ash	35	Granite	165–170
Beech	37	Gravel	117–125
Birch	40	Lime, quick (ground loose)	53
Cedar	22	Limestone	170
Cherry	30	Marble	164
Chestnut	26	Plaster of paris (cast)	80
Cork	15	Sand	90–106
Cypress	27	Sandstone	151
Ebony	71	Shale	162
Elm	30	Slate	160–180
Fir, Balsam	22	Terra-cotta	110
Hemlock	31	Traprock	170
Maple, Oak	62	Water	65
Pine, Poplar	30		

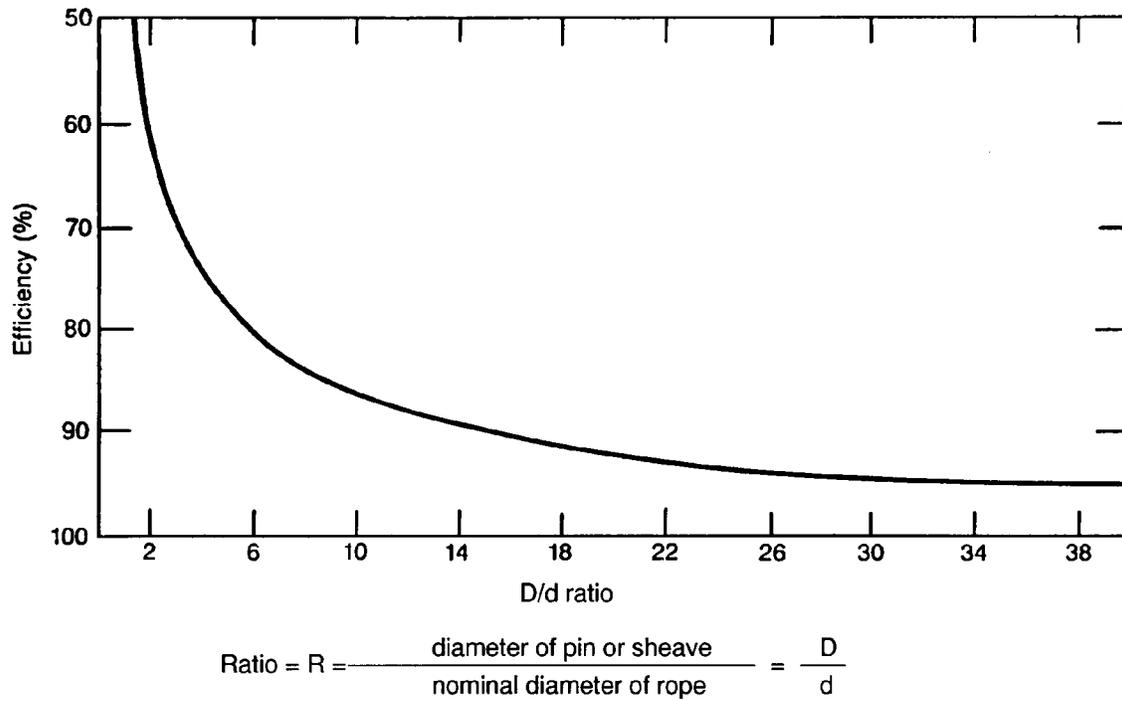


Figure 11-1. Efficiency of wire rope when bent and statically loaded to destruction over sheaves and pins of various diameters.

## 11.2 WIRE ROPE

### 11.2.1 Wire-Rope Lays

- a. In a right-lay rope, the strands twist to the right around the core like a conventional screw thread; in a left-lay rope, the strands twist to the left.
- b. A rope has a lang lay when the strands and the individual wires have the same lay direction. When the strands and the wires have an opposite lay direction, the rope has a regular lay.
- c. A standard wire rope, unless otherwise stated, is understood to be right regular lay. With few exceptions, all wire rope is made right lay. Left-lay rope is a special-purpose rope.
- d. Figure 11-2 shows ropes with right and left lays combined with regular and lang lays.
- e. Lay length is the lengthwise distance measured along a wire rope in which a strand makes one complete revolution about the rope's axis.

### 11.2.2 Wire-Rope Cores

- a. Wire rope consists of multistrand metal wires wrapped around a suitable core material. Wire-rope cores are carefully designed and must be precisely manufactured to close tolerances to ensure a perfect fit in the rope. The most common types of cores include the following (see Figure 11-3):

1. **Fiber Core (FC) or Sisal Core**—Sisalanna is the most common fiber that is used in the manufacture of wire-rope cores. In smaller ropes, cotton and jute are sometimes used for the core.

2. **Independent Wire-Rope Core (IWRC)**—The primary function of the core is to provide adequate support for the strands. As the name implies, an IWRC is a separate small-diameter wire rope that is used as the core for a larger wire rope. When severe crushing or flattening of the rope is encountered, an IWRC is usually specified.

3. **Strand Core**—This type of core has a single strand used as the core. This type is generally confined to the smaller ropes as a substitute for IWRC. The strand core may or may not have the same cross section as the surrounding strands.



Right Regular Lay



Left Regular Lay

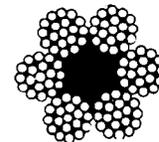


Right Lang Lay

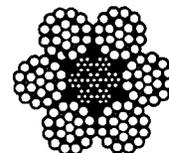


Left Lang Lay

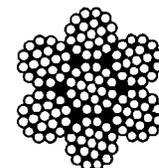
Figure 11-2. Wire-rope lays.



Fiber or Sisal Core



Independent Wire-Rope Core



Strand Core

Figure 11-3. Wire-rope cores.

## 11.2.3 Wire Rope for General Purposes

### 11.2.3.1 6 × 19 Classification

a. Most applications can use a rope from this classification; it is the most versatile of all ropes made. Figure 11-4 shows four varieties of 6 × 19 wire ropes with FCs and IWRCs. Table 11-2 provides breaking strengths for 6 × 19 wire ropes with FC and IWRC cores.

b. The principal types of ropes in this classification include:

1. **6 × 19F**—The most popular and versatile of all wire ropes and the most flexible is the 6 × 19F classification. This rope is considered the perfect compromise between maximum abrasion resistance and maximum flexibility.

2. **6 × 16F**—Slightly more abrasion resistant than the 6 × 19F, the 6 × 16F makes an excellent rope for small draglines and similar uses. The resistance to wear is gained by a slight sacrifice in flexibility.

3. **6 × 19 Seale**—The 6 × 19 Seale is a rugged wire rope for applications involving heavy wear. Car pullers often use this rope, and it is widely used for slushers and drag scrapers.

4. **6 × 19 Warrington**—The alternating large and small outer wires make this rope an all-around performer. The 6 × 19 Warrington is used for general-purpose hoisting, churn drills, and miscellaneous slings.

### 11.2.3.2 6 × 37 Classification

a. When sheaves and drums are fairly small and abrasive conditions are not severe, the ropes in this classification will show better performance than the coarser 6 × 19 construction. Under conditions of repeated bending, they will outlast a 6 × 19 rope; when abrasion is severe, the small outer wires quickly show the effect. Figure 11-5 shows three varieties of 6 × 37 wire rope with FC and IWRC cores. Table 11-3 provides breaking strengths for 6 × 37 wire ropes with FC and IWRC cores.

b. The principal types of ropes in this classification include:

1. **6 × 37 2-operation**—A 6 × 37 2-operation strand has 18 outer wires. This construction is used on industrial equipment, for flexible slings, and in miscellaneous hoisting.

2. **6 × 29F**—A 6 × 29F is used for applications requiring a flexible rope slightly more resistant to wear than the 6 × 37 2-operation rope.

3. **6 × 41**—A 6 × 41 rope is used widely for ropes over 1-in. diameter in the 6 × 37 classification.

## 11.2.4 Wire-Rope Inspections

A qualified inspector shall inspect wire ropes at least annually. Inspection requirements vary depending on what type of equipment the wire ropes are used on. Refer to other sections in this manual, based on the equipment being used, for specific inspection requirements.

## 11.2.5 Wire-Rope Maintenance

Personnel using wire rope shall ensure proper care by doing the following:

a. Store rope to prevent damage or deterioration.

b. Unreel or uncoil rope as recommended by the rope manufacturer or a qualified person and with care to avoid kinking or inducing a twist.

c. Before cutting a rope, use some method to prevent unlaying of the strands. Flame-cutting wire rope is prohibited.

d. During installation, avoid dragging the rope in the dirt or around objects that will scrape, nick, crush, or induce sharp bends.

e. Unless prohibited by other considerations, maintain rope in a well-lubricated condition. The object of rope lubrication is to reduce internal friction and to prevent corrosion. Ensure that lubricant applied as a part of a maintenance program is compatible with the original lubricant and is also a type that does not hinder visual inspection. Those sections of rope in contact with sheaves or otherwise hidden during inspection and maintenance procedures require special attention when lubricating rope.

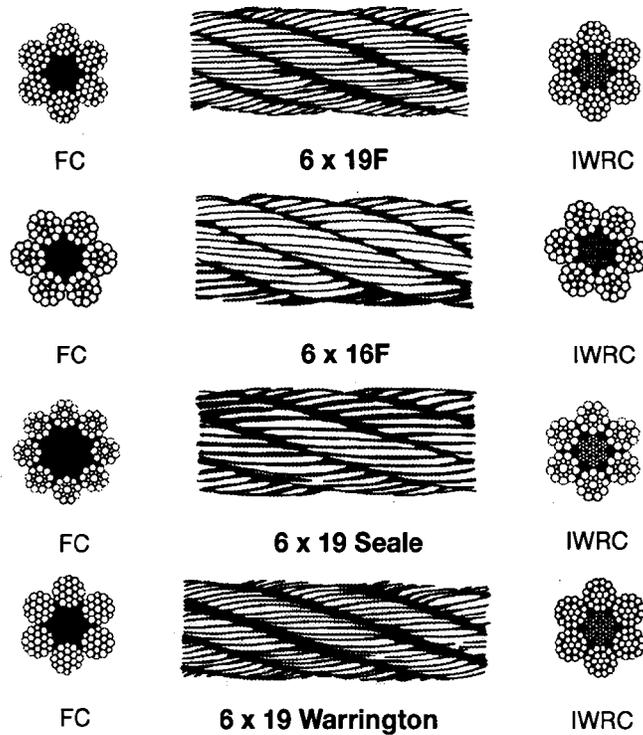


Figure 11-4. 6 x 19 classification of wire rope.

Table 11-2. Breaking strength of wire rope (6 x 19 classification).

6 x 19 (FC)				6 x 19 (IWRC)			
Rope diameter (in.)	Weight (lb per ft)	Breaking strength in tons of 2,000 lb		Rope diameter (in.)	Weight (lb per ft)	Breaking strength in tons of 2,000 lb	
		Plow steel	Improved plow steel			Plow steel	Improved plow steel
3/16	0.06	1.3	1.5	3/16	0.07	1.4	1.6
1/4	0.10	2.4	2.7	1/4	0.11	2.6	2.9
5/16	0.16	3.8	4.1	5/16	0.18	4.1	4.4
3/8	0.23	5.4	6.0	3/8	0.25	5.8	6.5
7/16	0.31	7.0	8.0	7/16	0.34	7.5	8.6
1/2	0.40	10.0	11.0	1/2	0.44	10.8	11.8
9/16	0.51	11.7	13.3	9/16	0.56	12.6	14.3
5/8	0.63	15.0	16.5	5/8	0.69	16.1	17.7
3/4	0.90	21.5	23.8	3/4	0.99	23.1	25.6
7/8	1.23	28.3	32.0	7/8	1.35	30.4	34.4
1	1.60	38.0	41.7	1	1.76	40.8	44.8
1 1/8	2.03	48.5	53.0	1 1/8	2.23	52.1	57.0
1 1/4	2.50	60.0	65.0	1 1/4	2.75	64.5	70.4
1 3/8	3.03	73.5	81.0	1 3/8	3.33	79.0	87.1
1 1/2	3.60	88.5	96.0	1 1/2	3.96	95.1	103.0
1 5/8	4.23	103.0	113.0	1 5/8	4.65	111.0	122.0
1 3/4	4.90	119.0	130.0	1 3/4	5.39	128.0	140.0
1 7/8	5.63	138.0	152.0	1 7/8	6.19	148.0	163.0
2	6.40	154.0	169.0	2	7.04	166.0	182.0
2 1/4	8.10	193.0	210.0	2 1/4	8.91	208.0	226.0
2 1/2	10.00	235.0	260.0	2 1/2	11.00	253.0	280.0
2 3/4	12.10	280.0	305.0	2 3/4	13.30	301.0	328.0

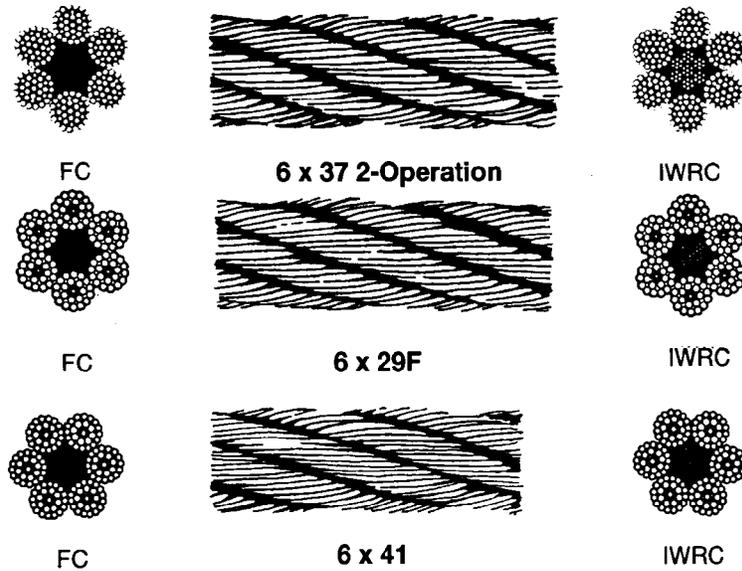


Figure 11-5. 6 x 37 classification of wire rope.

Table 11-3. Breaking strength of wire rope (6 x 37 classification).

6 x 37 (FC)				6 x 37 (IWRC)			
Rope diameter (in.)	Weight (lb per ft)	Breaking strength in tons of 2,000 lb		Rope diameter (in.)	Weight (lb per ft)	Breaking strength in tons of 2,000 lb	
		Plow steel	Improved plow steel			Plow steel	Improved plow steel
1/4	0.10	2.2	2.5	1/4	0.11	2.4	2.7
5/16	0.16	3.8	4.0	5/16	0.18	4.1	4.3
3/8	0.22	5.0	5.5	3/8	0.24	5.4	5.9
7/16	0.30	6.9	7.5	7/16	0.33	7.4	8.1
1/2	0.39	9.2	10.0	1/2	0.43	9.9	10.8
9/16	0.49	11.4	12.5	9/16	0.54	12.3	13.4
5/8	0.61	14.5	16.0	5/8	0.67	15.6	17.2
3/4	0.87	20.2	22.2	3/4	0.96	21.7	23.9
7/8	1.19	27.5	30.2	7/8	1.30	29.6	32.5
1	1.55	36.0	39.5	1	1.71	38.7	42.5
1 1/8	1.96	44.0	49.0	1 1/8	2.16	47.3	52.7
1 1/4	2.42	55.0	61.0	1 1/4	2.66	59.1	65.6
1 3/8	2.93	68.5	74.5	1 3/8	3.22	73.6	80.1
1 1/2	3.49	82.0	90.0	1 1/2	3.84	88.1	96.7
1 5/8	4.09	96.5	105.5	1 5/8	4.50	104.0	113.0
1 3/4	4.75	110.0	121.0	1 3/4	5.23	118.0	130.0
1 7/8	5.45	129.0	142.0	1 7/8	6.00	139.0	153.0
2	6.20	142.0	155.0	2	6.82	153.0	167.0
2 1/4	7.85	182.0	201.0	2 1/4	8.64	196.0	216.0
2 1/2	9.69	225.0	245.0	2 1/2	10.66	242.0	263.0
2 3/4	11.72	269.0	293.0	2 3/4	12.89	289.0	315.0
3	13.95	323.0	353.0	3	15.35	347.0	379.0

## 11.3 SLINGS

### 11.3.1 General

a. Slings shall have a minimum design factor appropriate to the type of material as specified in the appropriate section. Features that affect the rated capacity of the sling and that shall be considered in calculating the design factor are:

1. Nominal breaking strength of material from which it is constructed.
2. Splicing or end-attachment efficiency.
3. Number of parts in the sling.
4. Type of hitch (e.g., straight pull, choker hitch, or basket hitch).
5. Angle of loading and load center of gravity.
6. Diameter of curvature around which the sling is bent.

b. Published working loads for chain slings are usually based on 25–33 percent of the breaking strength.

c. The center of gravity of an object is a point around which the entire weight may be concentrated. To make a level lift, the crane hook or point of suspension must be directly above this point. While slight variations are usually permissible, if the crane hook is too far to one side of the center of gravity, dangerous tilting will result and should be corrected at once. For this reason, when the center of gravity is closer to one point of the sling attachment than to the other, the slings must be of unequal length. Sling stresses and sling angles will also be unequal (see Figure 11-6).

d. Slings shall be secured or terminated at the crane hook so that the sling does not reeve or slip through the hook. To attach the load, locate the center of gravity, position the crane hook directly above the center of gravity, and then rig the load so that it will lift level and true.

### 11.3.1.1 Load Angle Factor

a. The following is an example of selecting a sling using the load angle factors shown in Figure 11-7.

1. Load = 1,000 lb.
2. Sling = 2-legged bridle.
3. Angle with horizontal = 45 degrees.
4. Load angle factor from Figure 11-7 = 1.414.

b. Each of the two legs would lift 500 lb if a vertical lift were made. However, there is a 45 sling angle involved. Therefore, the 500-lb load would be multiplied by the load-angle factor in the chart, giving a total of 707 lb (500 lb  $\times$  1.414) tension in each sling leg. Each sling leg, therefore, must have a rated capacity of at least 707 lb.

### 11.3.1.2 Safe Load

a. The rated capacity or working load limit (WLL) of a sling varies depending on the type of hitch. The rated capacity tables in this section show the applications for which the various safe loads apply when the slings are new. All ratings are in pounds (lbs).

b. Figures 11-8 and 11-9 provide information for determining the total rated capacity of 3-leg and 4-leg bridle slings. Select multiple-leg slings so as not to introduce a working load in direct tension in any leg greater than that permitted. Two legs should be considered to carry the load because in normal lifting practice, the load will not be uniformly distributed on all legs. If rigging techniques, verified by a qualified rigger, ensure that the load is evenly distributed then full use of three legs is allowed. Special rigging techniques verified by a member of a qualified engineering organization shall be required to prove that a load is evenly distributed over four or more sling legs.

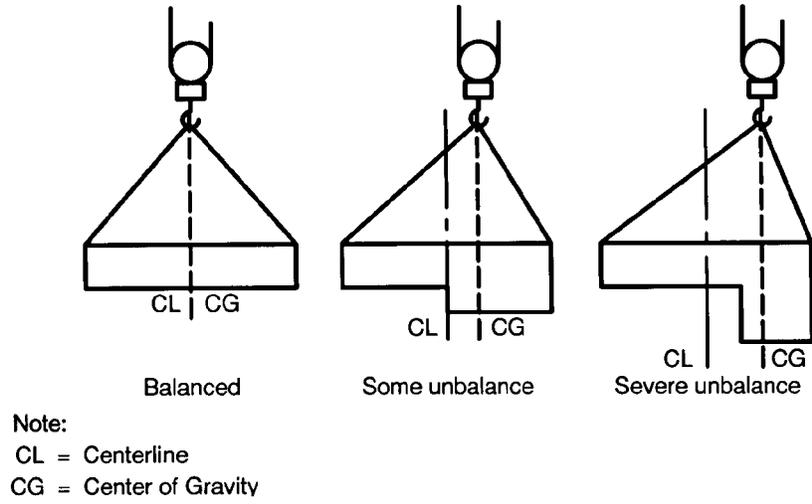
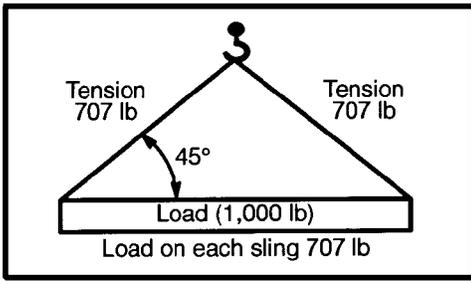
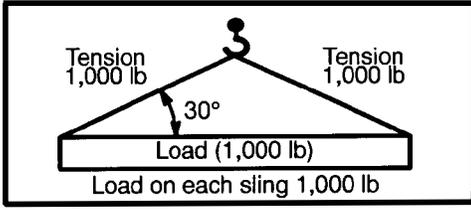
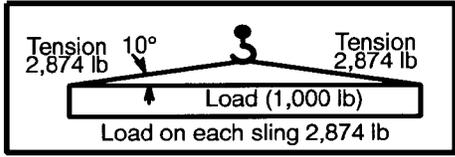
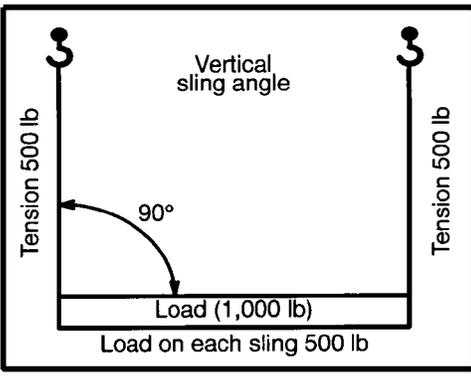


Figure 11-6. Balancing loads.



Sling angle	Load angle factor
90°	1.000
85°	1.004
80°	1.015
75°	1.035
70°	1.064
65°	1.104
60°	1.155
55°	1.221
50°	1.305
45°	1.414
40°	1.555
35°	1.742
30°	2.000
25°	2.364
20°	2.924
15°	3.861
10°	5.747
5°	11.490

Figure 11-7. Relationship of load angle and lifting efficiency.

### 11.3.1.3 Design Factor

In general, a design factor of 5:1 is maintained throughout this section. However, certain sling fittings, such as hooks (which will straighten without breaking) or links (which will deform beyond usefulness before breaking) cannot be assigned a definite numerical design factor. In such cases, suitable safe loads are listed, based on wide experience and sound engineering practice.

### 11.3.1.4 Sling Care

Proper care and usage are essential for maximum service and safety. Wire-rope slings shall be protected from sharp bends and cutting edges by means of corner saddles, burlap padding, or wood blocking. Overloading shall be avoided, as shall sudden dynamic loading that can build up a momentary overload sufficient to break the sling.

### 11.3.1.5 Sling Storage

Personnel using slings shall ensure that they are stored properly as follows:

- a. Slings should be stored in racks (preferably vertical) and in designated locations when not in use. Do not store slings in a location where they will be subjected to mechanical damage, corrosive action, moisture, extreme heat, or kinking. Slings may require segregated storage as determined on a case-by-case basis.
- b. Before storage and periodically during storage, wipe slings clean to remove as much dirt and abrasive grit as possible and relubricate wire rope and chain slings to extend their useful life. Chains should not be lubricated when in use.
- c. Do not store metal-mesh slings in areas where the temperature exceeds 550 degrees F (288 degrees C) or 200 degrees F (93 degrees C) if elastomer covered.
- d. Do not store synthetic-web slings where the temperature exceeds 200 degrees F (93 degrees C).

## 11.3.2 Wire-Rope Slings

a. In general, wire-rope slings are made up of  $6 \times 19$  or  $6 \times 37$  classification wire rope. Rotation-resistant wire rope shall not be used for wire-rope slings. Different kinds of slings have been developed for specific purposes. These are divided into different groups or types as follows:

1. Endless-loop slings (grommet construction) and single-part slings with single-rope legs, double-rope legs, or multiple-part rope legs.
2. Two-leg bridle slings with single-rope legs, equalizing double-rope legs, or multiple-part rope legs.
3. Three-leg bridle slings.
4. Four-leg bridle slings.
5. Special slings and combinations.

b. The total load that can be safely lifted with slings depends on the rating of the slings and the manner in which they are attached to the load. Consult (load) Tables 11-4 through 11-9 and Figure 11-10.

c. Braided slings are made by braiding ordinary wire ropes together, thus making them more flexible than wire-rope slings. The size of a braided sling is determined by the diameter of one wire rope and the number of ropes in the cross section of the sling.

d. The design factor for wire-rope slings shall be a minimum of 5:1 based upon breaking strength.

e. When a wire rope sling is used in a choker hitch, the normal angle formed in the rope body as it passes through the choking eye is 120 degrees or greater [do not confuse the choke angle with the angle of inclination of the load (see Figure 11-10)]. Rated load in load capacity Tables 11-4 through 11-9 are for angles of 120 degrees or greater. For smaller angles, reduce the rated load to the percentages given in Figure 11-10.

When legs are not of equal length, use smallest H/L ratio

NOTE: Load may be supported on only 2 legs while 3rd leg balances it. Therefore, the required SWL is determined by the following:

Total Rated Capacity = WLL  
(of single vertical hitch) x H/L x 2

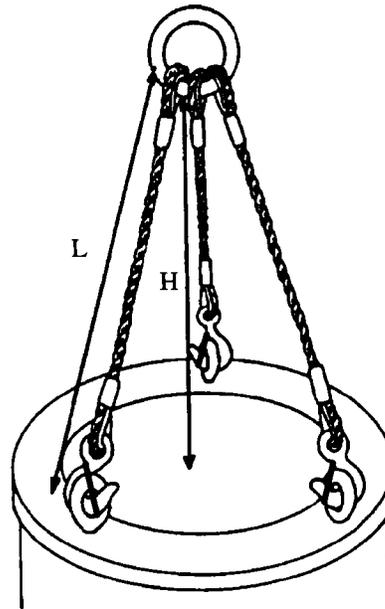


Figure 11-8. Determination of capacity—3-leg bridle sling.

When legs are not of equal length, use smallest H/L ratio.

NOTE: Load may be carried by only 2 legs while other 2 legs balance it. Therefore, the required SWL is determined by the following:

Total Rated Capacity = WLL (of single vertical hitch) x H/L x 2

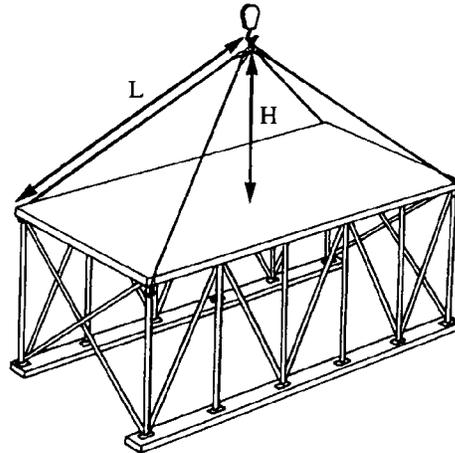
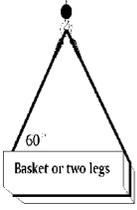
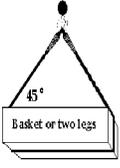


Figure 11-9. Determination of capacity—4-leg bridle sling.

**Table 11-4. Load capacity of wire-rope slings.  
Hand tuck splice (IWRC) in pounds Design Factor = 5:1**

							
Dia. in inches	Vertical	Choker	Basket or two legs	Basket or two legs	Basket or two legs	Basket or two legs	Dia. in inches
1/4	1,100	820	2,200	1,800	1,500	1,100	1/4
5/16	1,600	1,280	3,200	2,800	2,200	1,600	5/16
3/8	2,400	1,840	4,800	4,000	3,200	2,400	3/8
7/16	3,000	2,400	6,000	5,400	4,400	3,000	7/16
1/2	4,000	3,200	8,000	6,800	5,600	4,000	1/2
9/16	5,000	4,000	10,000	8,600	7,000	5,000	9/16
5/8	6,000	5,000	12,000	10,400	8,400	6,000	5/8
3/4	8,400	7,200	16,800	14,600	11,800	8,400	3/4
7/8	11,000	9,600	22,000	19,200	15,600	11,000	7/8
1	14,000	12,600	28,000	24,000	20,000	14,000	1
1 1/8	18,000	15,800	36,000	32,000	26,000	18,000	1 1/8
*1 1/4	22,000	19,400	44,000	36,000	30,000	22,000	*1 1/4
*1 3/8	26,000	24,000	52,000	44,000	36,000	26,000	*1 3/8
*1 1/2	32,000	28,000	64,000	52,000	42,000	32,000	*1 1/2
*1 5/8	36,000	32,000	72,000	62,000	50,000	36,000	*1 5/8
*1 3/4	42,000	38,000	84,000	70,000	58,000	42,000	*1 3/4
*2	56,000	48,000	112,000	92,000	74,000	56,000	*2

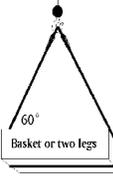
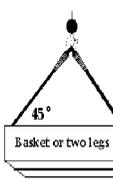
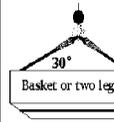
Wire Rope/6 x 19 and \*6 x 37 IPS IWRC

(CFR 1910.184/ANSI/ASME B30.9)

Notes:

- (1) These values only apply when the D/d ratio is 25 or greater (choker and basket hitches)  
D = Diameter of curvature around which the body of the sling is bent  
d = Diameter of rope
- (2) Choker hitch values apply only to choke angles greater than 120 degrees.

**Table 11-5. Load capacity of wire-rope slings.  
Hand tuck splice (Fiber Core) in pounds Design Factor = 5:1**

							
Dia. in inches	Vertical	Choker	Basket or two legs				Dia. in inches
1/4	980	760	1,960	1,700	1,400	980	1/4
5/16	1,500	1,200	3,040	2,600	2,200	1,500	5/16
3/8	2,200	1,700	4,400	3,600	3,000	2,200	3/8
7/16	2,800	2,400	5,600	5,000	4,000	2,800	7/16
1/2	3,600	3,000	7,200	6,400	5,200	3,600	1/2
9/16	4,600	3,800	9,200	8,000	6,400	4,600	9/16
5/8	5,600	4,600	11,200	9,600	8,000	5,600	5/8
3/4	7,800	6,600	15,600	13,600	11,000	7,800	3/4
7/8	10,400	9,000	20,800	17,800	14,600	10,400	7/8
1	13,400	11,800	26,800	22,000	18,800	13,400	1
1 1/8	16,800	14,800	33,600	28,000	24,000	16,800	1 1/8
*1 1/4	20,000	18,000	40,000	34,000	28,000	20,000	*1 1/4
*1 3/8	24,000	22,000	48,000	42,000	34,000	24,000	*1 3/8
*1 1/2	30,000	26,000	60,000	52,000	42,000	30,000	*1 1/2
*1 5/8	34,000	30,000	68,000	58,000	48,000	34,000	*1 5/8
*1 3/4	40,000	34,000	80,000	70,000	56,000	40,000	*1 3/4
*2	52,000	44,000	104,000	90,000	74,000	52,000	*2

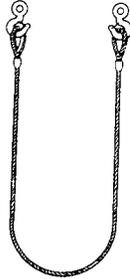
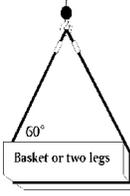
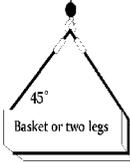
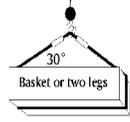
Wire Rope/6 x 19 and \*6 x 37 IPS FC

(CFR 1910.184/ANSI/ASME B30.9)

Notes:

- (1) These values only apply when the D/d ratio is 25 or greater (choker and basket hitches)
  - D = Diameter of curvature around which the body of the sling is bent
  - d = Diameter of rope
- (2) Choker hitch values apply only to choke angles greater than 120 degrees.

**Table 11-6. Load capacity of wire-rope slings.  
Mechanical splice (IWRC) in pounds Design Factor = 5:1**

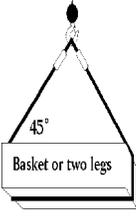
							
Dia. in inches	Vertical	Choker	Basket or two legs				Dia. in inches
1/4	1,100	840	2,200	1,940	1,580	1,100	1/4
5/16	1,700	1,300	3,400	3,000	2,400	1,700	5/16
3/8	2,400	1,860	4,800	4,200	3,600	2,400	3/8
7/16	3,400	2,500	3,800	5,800	4,800	3,400	7/16
1/2	4,400	3,200	8,800	7,600	6,200	4,400	1/2
9/16	5,500	4,200	11,000	9,600	7,700	5,500	9/16
5/8	6,800	5,000	13,600	11,800	9,600	6,800	5/8
3/4	9,700	7,200	19,400	16,800	13,600	9,700	3/4
7/8	13,000	9,800	26,000	22,000	18,300	13,000	7/8
1	17,000	12,800	34,000	30,000	24,000	17,000	1
1 1/8	20,000	15,600	40,000	36,000	30,000	20,000	1 1/8
*1 1/4	25,000	18,400	50,000	42,000	34,000	25,000	*1 1/4
*1 3/8	30,000	24,000	60,000	52,000	42,000	30,000	*1 3/8
*1 1/2	36,000	28,000	72,000	64,000	50,000	32,000	*1 1/2
*1 5/8	42,000	32,000	84,000	70,000	58,000	42,000	*1 5/8
*1 3/4	50,000	38,000	100,000	82,000	66,000	50,000	*1 3/4
*2	64,000	48,000	128,000	106,000	86,000	64,000	*2

(CFR 1910.184/ANSI/ASME B30.9)

Notes:

- (1) These values only apply when the D/d ratio is 25 or greater (choker and basket hitches)  
D = Diameter of curvature around which the body of the sling is bent  
d = Diameter of rope
- (2) Choker hitch values apply only to choke angles greater than 120 degrees.

**Table 11-7. Load capacity of wire-rope slings.  
8-part braided rope in pounds Design Factor = 5:1**

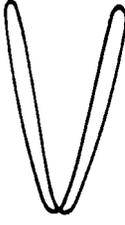
						
Dia. in inches	Vertical	Choker	Basket or two legs			Dia. in inches
*1/8	1,900	1,400	3,200	2,600	1,900	*1/8
*3/16	4,200	3,000	7,200	5,800	4,200	*3/16
3/16	3,400	2,600	6,000	4,800	3,400	3/16
1/4	6,200	4,600	10,600	8,600	6,200	1/4
5/16	9,600	7,200	16,600	13,400	9,600	5/16
3/8	13,600	10,200	24,000	19,400	13,600	3/8
7/16	18,000	13,800	32,000	26,000	18,600	7/16
1/2	24,000	18,000	42,000	34,000	24,000	1/2
9/16	30,000	22,000	52,000	42,000	30,000	9/16
5/8	38,000	28,000	64,000	52,000	38,000	5/8
3/4	54,000	40,000	92,000	76,000	54,000	3/4
7/8	72,000	54,000	124,000	102,000	72,000	7/8
1	94,000	70,000	162,000	132,000	94,000	1
Wire Rope/6 x 19 IPS and *7 x 7 Galvanized Aircraft Grade						

(CFR 1910.184/ANSI/ASME B30.9)

Notes:

- (1) These values only apply when the D/d ratio is 25 or greater (choker and basket hitches)  
D = Diameter of curvature around which the body of the sling is bent  
d = Diameter of rope
- (2) Choker hitch values apply only to choke angles greater than 120 degrees.

**Table 11-8. Load capacity of wire-rope slings.**  
**Cable laid grommet-hand tucked in pounds Design Factor = 5:1**

							
Dia. in inches	Vertical	Choker	Basket or two leg	60 degrees	45 degrees	30 degrees	Dia. in inches
*3/8	2,600	1,900	5,000	4,400	3,600	2,600	*3/8
*9/16	5,600	4,200	11,200	9,800	8,000	5,600	*9/16
*5/8	7,800	6,000	15,800	13,600	11,200	6,800	*5/8
3/4	10,200	7,600	20,000	17,600	14,400	10,200	3/4
15/16	15,800	11,800	32,000	28,000	22,000	15,800	15/16
1 1/8	22,000	16,800	44,000	38,000	32,000	22,000	1 1/8
1 5/16	30,000	22,000	60,000	52,000	42,000	30,000	1 5/16
1 1/2	38,000	28,000	78,000	66,000	54,000	38,000	1 1/2
1 11/16	48,000	36,000	98,000	84,000	68,000	48,000	1 11/16
1 7/8	60,000	44,000	120,000	104,000	84,000	60,000	1 7/8
2 1/4	84,000	62,000	168,000	146,000	118,000	84,000	2 1/4
2 5/8	112,000	84,000	224,000	194,000	158,000	112,000	2 5/8
3	144,000	108,000	286,000	248,000	202,000	144,000	3
Wire Rope/*7 x 6 x 7 and 7 x 6 x 19 IPS IWRC							

(CFR 1910.184/ANSI/ASME B30.9)

## Notes:

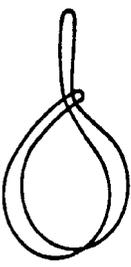
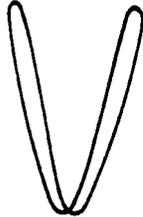
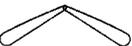
- (1) These values only apply when the D/d ratio is 10 or greater (choker and basket hitches)

D = Diameter of curvature around which the body of the sling is bent

d = Diameter of rope

- (2) Choker hitch values apply only to choke angles greater than 120 degrees.

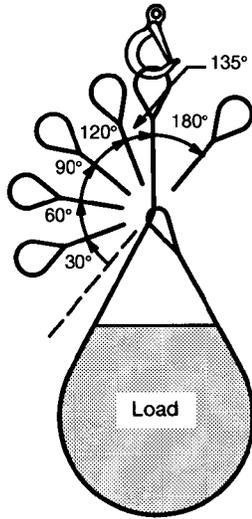
**Table 11-9. Load capacity of wire-rope slings.  
Strand laid grommet-hand tucked in pounds Design Factor = 5:1**

							
Dia. in inches	Vertical	Choker	Basket or two leg	60 degrees	45 degrees	30 degrees	Dia. in inches
1/4	1,840	1,320	3,600	3,200	2,600	1,840	1/4
3/8	4,000	3,000	8,000	7,000	5,800	4,000	3/8
1/2	7,000	5,200	14,000	12,200	10,000	7,000	1/2
5/8	10,800	8,000	22,000	18,800	15,200	10,800	5/8
3/4	15,200	11,400	30,000	26,000	22,000	15,200	3/4
7/8	20,000	15,200	40,000	34,000	28,000	20,000	7/8
1	26,000	19,400	52,000	44,000	36,000	26,000	1
1 1/8	30,000	22,000	62,000	52,000	44,000	30,000	1 1/8
*1 1/4	36,000	28,000	72,000	64,000	52,000	36,000	*1 1/4
*1 3/8	44,000	32,000	88,000	76,000	62,000	44,000	*1 3/8
*1 1/2	52,000	38,000	104,000	90,000	72,000	52,000	*1 1/2
*1 3/4	68,000	52,000	136,000	120,000	98,000	68,000	*1 3/4
*2	88,000	66,000	176,000	152,000	124,000	88,000	*2
Wire Rope/7 x 19 and *7 x 37 IPS IWRC							

(CFR 1910.184/ANSI/ASME B30.9)

Notes:

- (1) These values only apply when the D/d ratio is 10 or greater (choker and basket hitches)  
D = Diameter of curvature around which the body of the sling is bent  
d = Diameter of rope
- (2) Choker hitch values apply only to choke angles greater than 120 degrees.



Angle of choke in degrees	Rated capacity IWRC and FC rope percent **
Over 120	100
90-120	87
60-89	74
30-59	62
0-29	49

\*\*Percent of sling rated capacity in a choker hitch

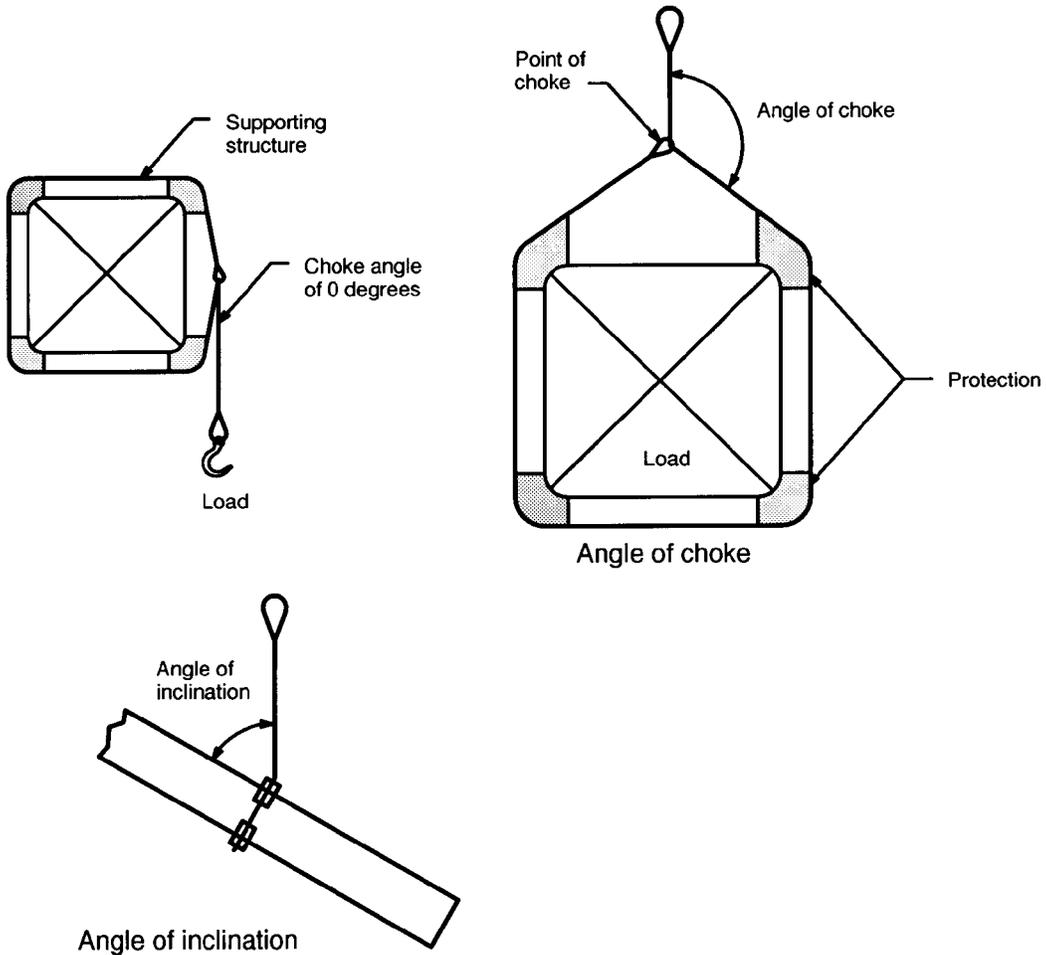


Figure 11-10. Choker hitch rated capacity adjustment.

**11.3.2.1 Inspections**

- a. Wire-rope sling users shall visually inspect all slings each day they are used or prior to use if the sling has not been in regular service (records are not required). In addition, a periodic inspection (with records) shall be made at least annually by a qualified inspector. More frequent intervals should be established if necessary as determined by a qualified person based on:
1. Frequency of sling use.
  2. Severity of service conditions.
  3. Nature of lifts being made.
  4. Experience gained on the service life of slings used in similar circumstances.
- b. Users shall carefully note any deterioration that could result in an appreciable loss of original strength and determine whether further use of the sling would constitute a safety hazard.
- c. A sample annual inspection form is included as Exhibit I at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.
- d. Inspection records shall be readily available.
- e. Slings shall be immediately removed from service if any of the following conditions are present:
1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.
  2. Wear or scraping of one-third the original diameter of the outside individual wire.
  3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
  4. Evidence of heat damage.
  5. End attachments that are cracked, deformed, or worn.
  6. Corrosion of the rope or end attachments.
- f. Hooks shall be inspected according to Chapter 12, "Rigging Accessories."

**11.3.2.2 Proof-Testing**

- a. All swaged and poured socket sling assemblies shall be certified as having been proof-tested. All other sling assemblies shall be proof-tested when specified by the purchaser.
- b. As a minimum, the proof load shall be equal to the rated capacity but shall not exceed:
1. 125 percent of the vertical rated capacity for single-leg, hand-tucked slings.
  2. 200 percent of the vertical rated capacity for mechanical-splice single-leg slings and endless slings.
- c. The proof-load for multiple-leg bridle slings shall be applied to the individual legs and shall be either 200 percent for mechanical splice or 125 percent for hand-tucked splice, times the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.
- d. Welded end attachments shall not be used unless proof-tested at 2 times rated capacity prior to initial use.
- e. Test loads described above shall be accurate to within -5 percent, +0 percent of stipulated values. A written letter of certification by the manufacturer or a pull test witnessed and certified in writing by a qualified person is acceptable.

**11.3.2.3 Operation**

The following shall apply to all personnel who use wire-rope slings:

- a. Ordinary Lifts
1. Start and stop slowly; sudden starts and stops dramatically increase the stresses in hoist ropes and slings. Lift slowly until the load is suspended to minimize swinging.
  2. Loads shall be set on blocks. Do not pull a sling from under a load that is resting on the sling.
  3. Ensure that wire-rope slings are protected against weather, chemicals, solvents, and high temperatures.
  4. Permanently remove from service fiber-core rope slings that have been exposed to

temperatures in excess of 180 degrees F (82 degrees C).

5. Obtain the manufacturer's written approval for use of wire rope slings of any grade at temperatures between 400 degrees F (204 degrees C) and -60 degrees F (-51 degrees C).

6. Extremely low temperatures (less than 0 degrees F) may cause brittle fractures. Under these conditions, sudden loading should be avoided and the rope should be carefully observed while the load is being applied.

7. Do not use knotted slings.

8. Do not use single-leg wire-rope slings unless proper precautions are taken to prevent suspended loads from rotating.

9. Secure each leg of a wire-rope sling at the hook to prevent reeving of the sling through the hook.

10. Do not make a complete turn of wire rope around the crane hook.

11. Use protector pads or blocking at sharp corners.

12. Avoid handling hot material with wire-rope slings.

13. Use shackles or adjustable choker hooks when making choker hitches.

14. Store slings on racks away from moisture and acids when not in use.

15. Ensure that damaged wire-rope slings are rendered unusable, removed from service, discarded, and replaced with new slings.

16. Before use and before storage, check wire-rope slings for:

- i. Broken or cut wires or strands.
- ii. Rust or corrosion.
- iii. Kinks.
- iv. Broken seizing wire.
- v. Damage to swaged fittings.
- vi. Other signs of damage or abuse.

17. The capacity of wire-rope slings is derated by the manufacturer by applying the efficiency factors such as those given in Figure 11-11.

18. Do not use wire-rope clips to fabricate wire-rope slings except where the application of slings prevents the use of prefabricated slings or where the specific application is designed by a qualified person. Slings made with wire rope clips should not be used as a choker hitch (see Figures 11-12 and 11-13).

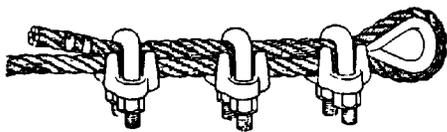
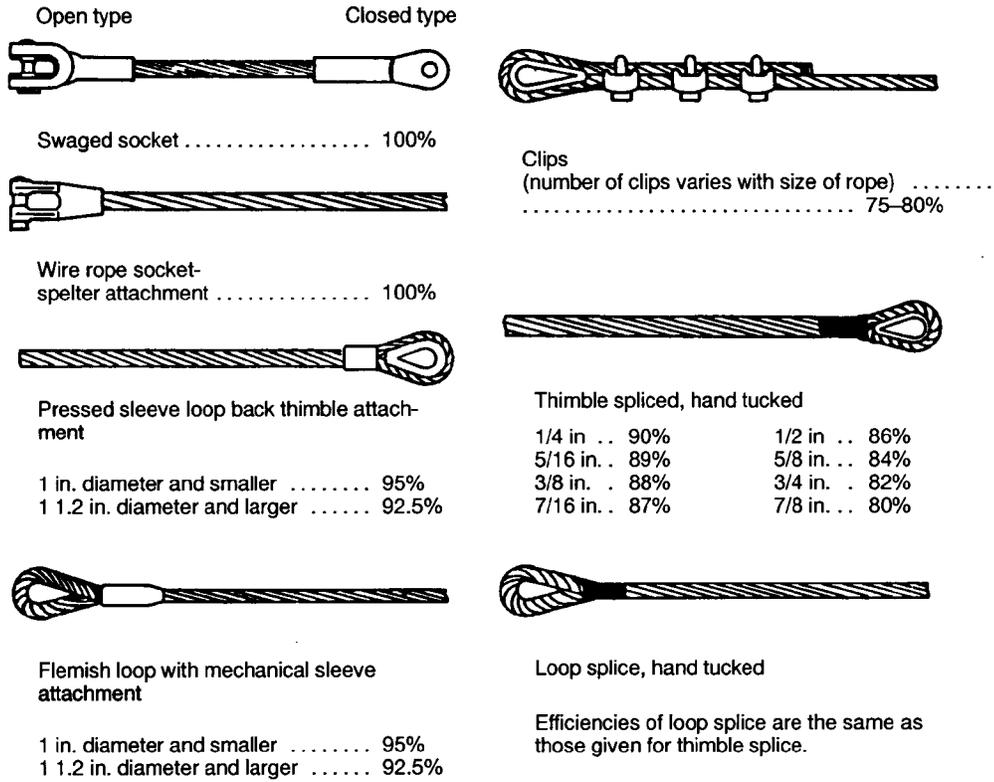
19. When wire-rope clips are used, the rating of the sling must be derated to 80 percent of the wire-rope rating to allow for the inefficiency of the clips.

20. Double-saddle clips or fist-grip clips (Figure 11-14) may be used to make up general-purpose slings provided the sling is derated to 95 percent of wire-rope capacity.

21. Follow the requirements of 29 CFR 1926.251, Table H-20 or the manufacturer's recommendation (whichever offers the greater protection) for the number of clips required, correct spacing, and torque. After the initial load is applied to the rope, retighten the clip nuts to the recommended torque to compensate for any decrease in rope diameter caused by the load. Rope clip nuts should be retightened to the recommended torque periodically to compensate for further decrease in rope diameter during usage.

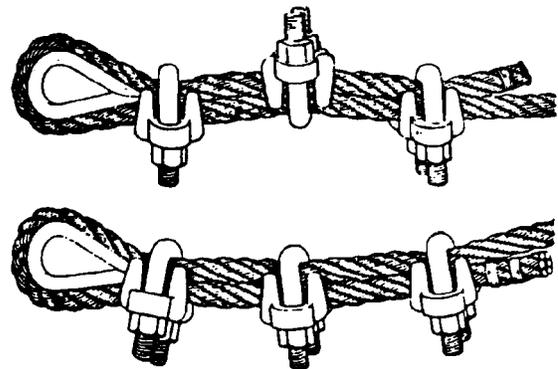
Figure 11-11. Wire-rope fastenings.

Efficiencies of wire rope fittings or fastenings  
in percentages of strength of rope:



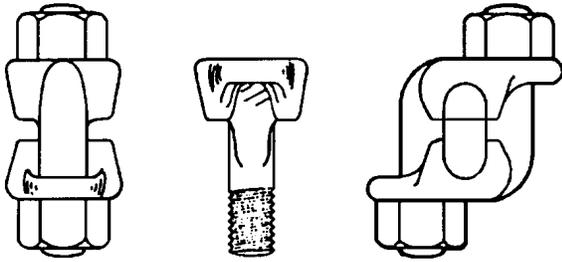
Note that the base of the clip bears against the live end of the wire rope, while the "U" of the bolt presses against the dead end.

Figure 11-12. Wire-rope clips—right way.



The "U" of the clips should not bear against the live end of the wire rope because of the possibility of the rope being kinked or crushed.

Figure 11-13. Wire-rope clips—wrong way.



**Figure 11-14. Double-saddle clips (drop-forged steel, galvanized).**

22. As a minimum, mark wire-rope slings with the rated capacity and inspection due date. This information may be stenciled or stamped on a metal tag affixed to the sling. (Stenciling or stamping on the swages of a sling eye is not recommended.)

23. Slings made of rope with  $6 \times 19$  and  $6 \times 37$  construction and cable-laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings.

24. Braided slings shall have a minimum clear length of rope 40 times the component (individual) rope diameter between the loops or end fittings.

25. Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling.

#### b. Critical Lifts

1. All provisions of paragraph 11.3.2.3.a, “Ordinary Lifts,” also shall apply to critical lifts.

2. Wire-rope sling eyes with thimbles shall be made with a thimble having a ratio of thimble diameter (D) to rope diameter (d) of 3 or more (D/d greater than or equal 3).

3. Do not use wedge sockets or wire-rope clips on slings used for critical lifts.

4. Ensure that working loads of wire-rope slings do not exceed their rated capacities.

5. Do not splice slings together.

6. Use thimble eyes for slings to be joined end-to-end.

7. Locate sling eyes so that:
  - i. Adequate clearance is maintained between the attached slings and other parts or surfaces of the component or equipment.
  - ii. There is no interference with the functioning of hoisting, rigging, or handling equipment.
  - iii. Maximum accessibility to the eye is maintained.
  - iv. Attached slings can converge over the center of gravity of the lift.
  - v. Proper stability can be maintained during lifting and positioning of the item at the installation site.
  - vi. The plane of the slinging eye is coincident with the plane of the sling under loaded conditions within  $\pm 5$  degrees.
  - vii. Sling angles are not less than 45 degrees with the horizontal.

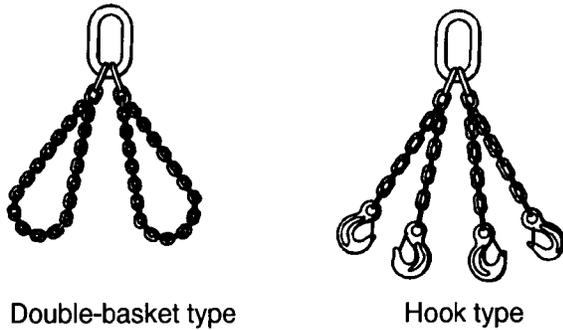
8. In addition to marking requirements listed for ordinary lifts, other items may need to be marked as determined on a case-by-case basis, such as the reach, type, weight of the sling assembly, and rated capacity.

### 11.3.3 Alloy Steel-Chain Slings

a. This section applies to slings made from grade 80 alloy chain manufactured and tested in accordance with National Association of Chain Manufacturers welded steel chain specifications—1990. If chain other than this is used, it shall be used in accordance with the recommendations of the chain manufacturer.

b. Alloy Steel-chain slings differ from wire-rope slings in that components using wire are replaced by link chain. Other sling components are similar. Chain slings are more rugged and flexible, but less shock resistant than wire-rope or braided slings. The size is measured by the link stock.

c. Two basic types with many variations are used: basket type and hook type. An example of each is shown in Figure 11-15.



**Figure 11-15. Types of chain slings.**

d. Alloy-steel-chain slings shall not be heated above 1,000 degrees F (537 degrees C) after being received from the manufacturer.

e. When exposed to service temperatures in excess of 600 degrees F (315 degrees C), reduce working load limits in accordance with the chain manufacturer's recommendations.

f. Extremely low temperatures (less than 0 degrees F) may cause brittle fractures. Under these conditions, sudden loading should be avoided and the load should be lifted a very short distance while the chains are carefully inspected.

g. The design factor for steel-chain slings shall be a minimum of 4:1 based upon breaking strength.

h. Chains should be stored in racks or in designated locations when not in use. Chains should never be stored in damp or dirty places, nor in places exposed to the weather. For long-term storage, they should receive a coating of oil. The ends of all empty chains should be hooked onto the hoist hook or bull ring.

i. Chains should not be lubricated when in use because this might make them dangerous to handle. Chains should be cleaned periodically to remove abrasive grit and to facilitate inspection.

j. The total load that can be lifted safely with steel-chain slings depends on the manner by which

the slings are attached to the load. If all legs of a steel-chain sling are hooked back into the master link, the safe-load capacity of the whole sling may be increased by 100 percent if the capacity of the master link is not exceeded.

k. The safe-load level of any chain sling is a function of three basic factors: size and number of legs, condition of chain and other components, and sling angle between legs and horizontal. Table 11-10 shows safe loads in pounds per leg which can be carried by various chain-sling arrangements. Note the effect of very low hook height and wide leg spreads.

### 11.3.3.1 Pre-Use Inspections

Steel-chain sling users shall visually inspect all slings before they are used as follows:

a. Conduct a link-by-link inspection for the following defects: bent links, stretched links, cracks in any section of link, scores, abrasions, heat damage, or markings tending to weaken the links. Reject if discovered.

b. Check rings and hooks for distortion, cracks in weld areas, corrosion, and scores, heat damage, or markings tending to weaken the links. Reject if discovered.

c. Perform inspection on an individual-link basis. If any link does not hinge freely with the adjoining link, remove the assembly from service.

d. Remove from service assemblies with deformed master links or coupling links.

e. Remove from service assemblies if hooks have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

f. Do not straighten deformed hooks or other attachments on the job. Assemblies with such defects shall be reconditioned by the manufacturer or discarded.

g. Remove from service assemblies with cracked hooks or other end attachments; assemblies with such defects shall be reconditioned or repaired prior to return to service.

Table 11-10. Alloy steel chain slings in pounds Design Factor = 4:1

Size in inches	 Single Leg	 60° Two Legs	 45° Two Legs	 30° Two Legs	Size in inches
9/32	3,500	6,100	4,900	3,500	9/32
3/8	7,100	12,300	10,000	7,100	3/8
1/2	12,000	20,800	17,000	12,000	1/2
5/8	18,100	31,300	25,600	18,100	5/8
3/4	28,300	49,000	40,000	28,300	3/4
7/8	34,200	59,200	48,400	34,200	7/8
1	47,700	82,600	67,400	47,700	1
1 1/4	72,300	125,200	102,200	72,500	1 1/4

(CFR 1910.184/ANSI/ASME B30.9)

## Notes:

- (1) Other grades of proof tested steel chain include Proof Coil (Grade 28), Hi-Test (Grade 43) Chain and Transport (Grade 70) Chain. These grades are not recommended for overhead lifting and therefore are not covered in the applicable standards.
- (2) Rating of multileg slings adjusted for angle of loading between the inclined leg and the horizontal plane of the load.

**11.3.3.2 Annual Inspections**

- a. A sample annual inspection form is included as Exhibit II at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.
- b. Annual inspections shall be conducted by a qualified inspector. In addition to criteria for daily inspections, the qualified inspector shall do the following for annual inspections:
1. Hang chain in a vertical position, if practicable, for preliminary inspection. Chain should hang reasonably straight if links are not distorted.
  2. Accurately measure the reach (inside of crane ring to inside of hook) under no load when new and at each inspection, and keep a record of increase in length; an increase in length may be due to stretch (sign of overload or wear).
  3. Check for localized stretch and wear. Lift each link from its seat and visually inspect for grooving. If grooving is noticed, verify stock diameter of link to be within the minimum safe dimensions in the table below. Reject chain if it does not meet the requirements in the table.
  4. Remove the assembly from service if wear at any point of any chain link exceeds that shown in Table 11-11.
  5. Round out sharp transverse nicks by grinding. If the minimum dimensions are reduced below those values specified in Table 11-11, remove the assembly from service.

**Table 11-11. Maximum allowable wear of chains.**

Chain size (in.)	Maximum allowable wear (in.)
1/4	3/64
3/8	5/64
1/2	7/64
5/8	9/64
3/4	10/64
7/8	11/64
1	12/64
1-1/4	16/64

**NOTE: For other sizes, consult chain or sling manufacturer.**

6. Check for evidence of heat damage.

**11.3.3.3 Proof-Testing**

- a. Single-leg and endless alloy-steel chain slings shall be certified as having been proof-tested to 200 percent of the rated capacity prior to initial use.
- b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.
- c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

**11.3.3.4 Operation**

- a. The following shall apply to all personnel who use steel-chain slings:
1. Do not set a load on a sling or pull a sling from under a load. Place wooden blocks or other supports under the load to provide sufficient clearance for the chain.
  2. Shorten chain slings by hooking back into the chain, into the master link, or with grab hooks. Do not shorten by knotting, twisting, bolting, or inserting the tip of the hook into a link.
  3. Do not hammer a chain to force it into position.
  4. Protect chain slings from sharp corners that might bend the links. Use a suitable pad to prevent gouging or bending of the chain links, as well as possible scarring of the load.
  5. When making choker hitches with chain slings, always face the hook opening out and away from the pull of the sling so that the hooks will not slip out when slack is taken out of the sling.
  6. Check steel-chain slings for:
    - i. Nicks, cracks, gouges, and wear.
    - ii. Bending, stretching, or shearing of links.

- iii. Bends or distortions in hooks.
  - iv. Rust and corrosion.
  - v. Uneven lengths when sling legs are hanging free.
  - vi. Evidence of heat damage.
7. Do not weld or perform local repairs on chain slings. All defective chain slings should be returned, through a formal procedure, to the manufacturer for examination, repair, and recertification.
8. Avoid sudden loading of chain slings.
9. Maintain latches on hooks in good condition.
10. If a chain sling does not look safe, do not use it. Do not assume that a chain sling is safe because it looks new; look for stretched links. If in doubt, check with the supervisor.
11. Do not carry loads on the point or tip of a hook.
12. Avoid unbalanced loads.
13. Do not use homemade links, makeshift fasteners formed from bolts, rods, and the like, or other nonstandard attachments.
14. Do not use makeshift or field-fabricated hooks on steel-chain slings.
15. Hook the ends of all empty chain onto the hoist hook or bull ring.
16. Ensure that steel-chain slings used in DOE-controlled areas are marked, at a minimum, with:
- i. Size.

- ii. Manufacturer's grade.
- iii. Rated load and angle on which the rating is based.
- iv. Reach.
- v. Number of legs.
- vi. Sling manufacturer.
- vii. Inspection due date.

17. This information may be stenciled or stamped on a metal tag or tags affixed to the sling.

18. Where slings have more than one leg, ensure that the tag is affixed to the master link.

19. Ensure that the working load does not exceed the rated capacity of the sling.

### 11.3.4 Metal-Mesh Slings

a. Metal-mesh slings (Figure 11-16) shall be classified with the designations shown in Table 11-12, based on types of duty and material classification.

**Table 11-12. Metal-mesh sling designations.**

Type	Classification	Designation
Heavy duty	Carbon steel	35-CS
	Stainless steel	35-SS
Medium duty	Carbon steel	43-CS
	Stainless steel	43-SS
Light duty	Carbon steel	59-CS
	Stainless steel	59-SS

b. The carbon steel used in metal-mesh slings shall be processed to produce the required mechanical properties.

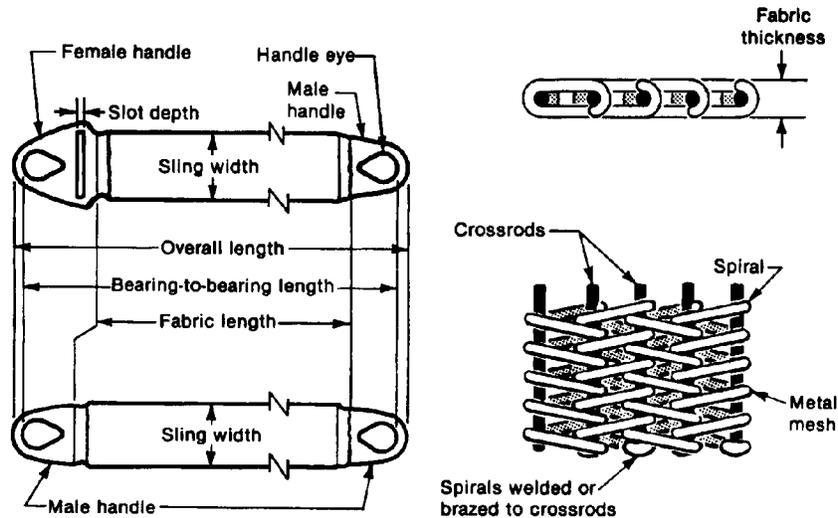


Figure 11-16. Typical metal-mesh sling.

c. The material used for stainless-steel metal-mesh slings shall conform, at least, to the American Iron and Steel Institute standards for Type-302 or Type-304 stainless steel. Other materials may be used. When metal-mesh slings are produced from such materials, however, the sling manufacturer should be consulted for specific data.

d. The handle shall be designed to ensure:

1. At least the same rated capacity as the fabric.
2. No visible permanent deformation after proof-testing.

e. The fabric and handles shall be so joined that:

1. The rated capacity of the sling is not reduced.
2. The load is evenly distributed across the width of the fabric.
3. Sharp edges do not damage the fabric.

f. Metal-mesh slings may be painted, plated, impregnated with elastomers such as neoprene or

polyvinyl chloride (PVC), or otherwise suitably coated. The coating shall not diminish the rated capacity of a sling.

g. The design factor for metal-mesh slings shall be a minimum of 5:1 based upon breaking strength.

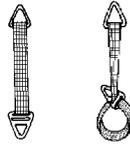
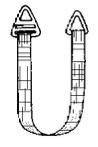
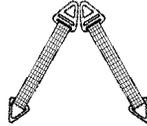
h. Metal-mesh slings shall not be used to lift loads greater than the rated capacity, properly derated for other than straight-pull configurations (Table 11-13).

i. Except for elastomer-impregnated slings, all metal-mesh slings covered by this section may be used without derating in a temperature range from -20 degrees F (-29 degrees C) to 550 degrees F (288 degrees C).

j. All metal-mesh slings covered by this section and impregnated with PVC or neoprene shall be used only in a temperature range from 0 degrees F (-18 degrees C) to 200 degrees F (93 degrees C).

k. For operation at temperatures outside these ranges or for other impregnations, consult the manufacturer for specific data.

**Table 11-13. Load capacity of carbon and stainless-steel metal-mesh slings in pounds  
Design Factor = 5:1**

Sling width(in.)	 Vertical or choker	 Basket or two legs	 60° Basket or two legs	 45° Basket or two legs	 30° Basket or two legs	Sling width(in.)
Heavy duty 10-ga 35 spirals/ft of mesh width						
2	1,500	3,000	2,600	2,100	1,500	2
3	2,700	5,400	4,700	3,800	2,700	3
4	4,000	8,000	6,900	5,600	4,000	4
6	6,000	12,000	10,400	8,400	6,000	6
8	8,000	16,000	13,800	11,300	8,000	8
10	10,000	20,000	17,000	14,100	10,000	10
12	12,000	24,000	20,700	16,900	12,000	12
14	14,000	28,000	24,200	19,700	14,000	14
16	16,000	32,000	27,700	22,600	16,000	16
Medium duty 12-ga 43 spirals/ft of mesh width						
2	1,350	2,700	2,300	1,900	1,400	2
3	2,000	4,000	3,500	2,800	2,000	3
4	2,700	5,400	4,700	3,800	2,700	4
6	4,500	9,000	7,800	6,400	4,500	6
8	6,000	12,000	10,400	8,500	6,000	8
10	7,500	15,000	13,000	10,600	7,500	10
12	9,000	18,000	15,600	12,700	9,000	12
14	10,500	21,000	18,200	14,800	10,500	14
16	12,000	24,000	20,800	17,000	12,000	16
Light duty 14-ga 59 spirals/ft of mesh width						
2	900	1,800	1,600	1,300	900	2
3	1,400	2,800	2,400	2,000	1,400	3
4	2,000	4,000	3,500	2,800	2,000	4
6	3,000	6,000	5,200	4,200	3,000	6
8	4,000	8,000	6,900	5,700	4,000	8
10	5,000	10,000	8,600	7,100	5,000	10
12	6,000	12,000	10,400	8,500	6,000	12
14	7,000	14,000	12,100	9,900	7,000	14
16	8,000	16,000	13,900	11,300	8,000	16

(CFR 1910.184/ANSI/ASME B30.9)

**11.3.4.1 Inspections**

- a. Users of metal-mesh sling shall visually inspect all metal-mesh slings before each use.
- b. Annual inspections shall be made by a qualified inspector, and inspection records shall be kept on file and be readily available.
- c. Metal-mesh slings shall be removed from service if any of the following defects are present:
  1. A broken weld or brazed joint along the sling edge.
  2. A broken wire in any part of the mesh.
  3. Reduction in wire diameter of 25 percent due to abrasion or 15 percent due to corrosion.
  4. Lack of flexibility due to distortion of the mesh.
  5. Distortion of the female handle so the depth of the slot is increased by more than 10 percent.
  6. Distortion of either end fitting so the width of the eye opening is decreased by more than 10 percent.
  7. A 15 percent reduction of the original cross-sectional area of metal at any point around a handle eye.
  8. Any distortion or twisting of either end fitting out of its plane.
  9. Cracked end fitting.
  10. Evidence of heat damage.

**11.3.4.2 Proof-Testing**

- a. Metal-mesh slings shall be certified as having been proof-tested to 200 percent of their rated capacity prior to initial use.
- b. Coated slings shall be proof-tested prior to being coated.
- c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

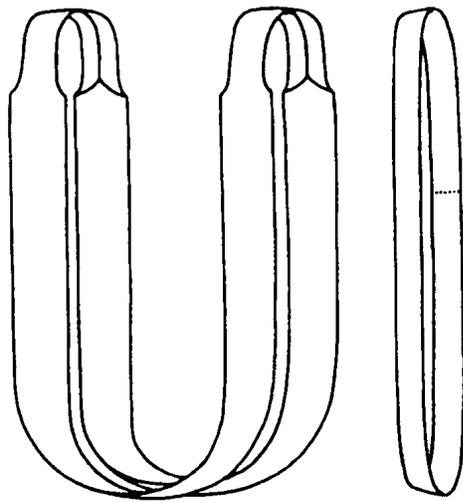
**11.3.4.3 Operation**

- a. The following shall apply to all personnel who use metal-mesh slings:
  1. Ensure that the weight of the load is within the rated capacity of the sling.
  2. Ensure that metal-mesh slings have suitable characteristics and rated capacity for the load and environment.
- b. Metal-mesh slings should be long enough to provide the maximum practical angle between the sling leg and the horizontal (minimum practical angle at the crane hook if vertical angles are used).
- c. Do not shorten metal-mesh slings with knots, bolts, or other unapproved methods.
- d. Do not use damaged slings.
- e. Securely hitch metal-mesh slings to the load.
- f. Ensure that sharp corners are padded.
- g. Keep hands and fingers out of the area between the sling and the load.
- h. Ensure that all personnel stand clear of the suspended load.
- i. Avoid shock loading.
- j. Do not pull metal-mesh slings from under a load when the load is resting on the sling.
- k. Do not store metal-mesh slings in an area where they will be subjected to mechanical damage or corrosive action.
- l. Avoid twisting and kinking of the legs.
- m. In a choker hitch, ensure that metal-mesh slings are long enough so that the female handle chokes freely on the mesh, never on the handle.
- n. In a choker hitch, ensure that the load is balanced. When this cannot be done, consult the manufacturer for a derating factor or for other means of handling this type of load.
- o. In a basket hitch, ensure that the load is balanced to prevent slippage.
- p. Do not use metal-mesh slings in which the spirals are locked or are without free articulation.

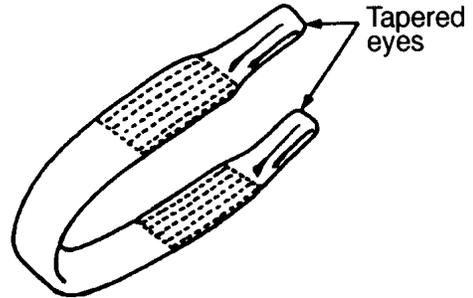
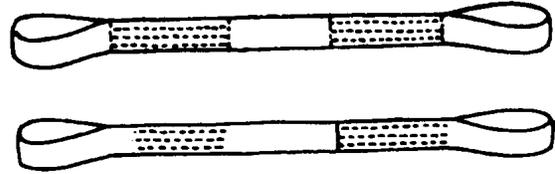
- q. Never hammer a sling to straighten a spiral or cross rod or to force a spiral into position.
- r. Metal-mesh slings used in pairs should be attached to a spreader beam.
- s. Ensure that all metal-mesh slings have a permanently affixed metal identification tag or tags containing the following information:
  1. Manufacturer's name or trademark.
  2. Rated load in vertical, basket, and choker hitches.
  3. Inspection due date.

### 11.3.5 Synthetic-Web Slings

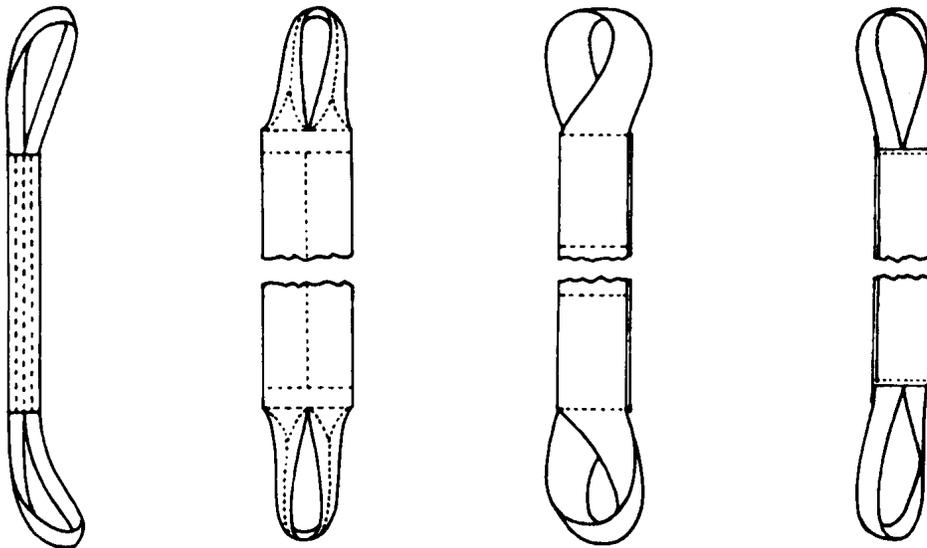
- a. Synthetic web shall possess the following qualities:
  1. Be of sufficient strength to meet the sling manufacturer's requirements.
  2. Have uniform thickness and width.
  3. Have selvage edges and not be split from its woven width.
- b. The thread used in the manufacture of a synthetic-web sling shall be of the same type of material as the web.
- c. Fittings shall be:
  1. Of sufficient strength to sustain twice the rated capacity without permanent deformation.
  2. Of a minimum breaking strength equal to that of the sling.
  3. Free of all sharp edges that would in any way damage the mesh.
- d. The stitching in all load-bearing splices shall be of sufficient strength to maintain the sling design factor.
- e. Synthetic-web slings may be coated with elastomers or other suitable material that will provide characteristics such as abrasion resistance, sealing of pores, and increased coefficient of friction.
- f. The design factor for synthetic-web slings shall be a minimum of 5:1 based upon breaking strength.
- g. Rated capacities are affected by the type of hitch used and by the angle from the vertical when used as multilegged slings or in basket hitches. The sling manufacturer shall supply data on these effects.
- h. Synthetic-web slings are available in a number of configurations as follows (see Figure 11-17):
  1. *Endless or Grommet Sling*—Both ends of one piece of webbing are lapped and sewn to form a continuous piece. They can be used as vertical hitches, bridle hitches, in choker arrangements, or as basket slings. Because load contact points can be shifted with every lift, wear is evenly distributed and sling life is extended.
  2. *Standard Eye and Eye*—Webbing is assembled and sewn to form a flat-body sling with an eye at each end and the eye openings in the same plane as the sling body. The eyes may either be full web width or may be tapered by being folded and sewn to a width narrower than the webbing width.
  3. *Twisted Eye*—An eye-and-eye type that has twisted terminations at both ends. The eye openings are at 90 degrees to the plane of the sling body. This configuration is also available with either full-width or tapered eyes.
- i. In place of the sewn eyes, synthetic-web slings are also available with metal end fittings (see Figure 11-18). The most common are triangle and choker hardware. Combination hardware consists of a triangle for one end of the sling and a triangle/rectangle choker attachment for the other end. With this arrangement, both choker and basket hitches, as well as straight hitches, may be rigged. They help reduce wear in the sling eyes and thus lengthen sling life.



**Endless or grommet slings**



**Standard eye-and-eye slings**



**Twisted-eye slings**

**Figure 11-17. Synthetic-web sling types.**

j. Despite their inherent toughness, synthetic-web slings can be cut by repeated use around sharp-cornered objects. They eventually show signs of abrasion when they are repeatedly used to hoist rough-surfaced products. There are, however, protective devices offered by most sling manufacturers that minimize these effects (see Figure 11-19). Other protective devices include:

1. Buffer strips of leather, nylon, or other materials that are sewn on the body of a sling protect against wear. Leather pads are the most resistant to wear and cutting, but are subject to weathering and gradual deterioration. They are not recommended in lengths over 6 ft due to the different stretching characteristics of leather and webbing. On the other hand, nylon-web wear pads are more resistant to weathering, oils, grease, and most alkalis; and they stretch in the same ratio as the sling body.

2. Edgeguards consist of strips of webbing or leather sewn around each edge of the sling. This is necessary for certain applications where the sling edges are subject to damage.

3. Sleeve- or sliding-tube-type wear pads are available for slings used to handle material having sharp edges. They can be positioned on the sling where required, do not move when the sling stretches, adjust to the load, and cover both sides of the sling.

4. Reinforcing strips that double or triple the eye's thickness and greatly increase its life and safety can be sewn into the sling eyes.

5. Coatings can be applied to provide added resistance to abrasion and chemical damage. These treatments also increase the coefficient of friction, affording a better grip when loads with slippery surfaces are to be handled. These coatings can be brightly colored for safety or load-rating purposes.

6. Cotton-faced nylon webbing can be used for hoisting rough-surfaced material.

k. The synthetic-web sling capacities listed in Tables 11-14 and 11-15 are approximate only and

are based on nylon webbing having breaking strengths between 6,000 and 9,000 lb/in. of webbing width. The capacities are also based on a 5:1 design factor and assume that the end fittings are of adequate strength.

- l. Although safe working loads for bridle hitches in the choker or double-basket configuration are provided, they should be used only with extreme caution because, as the sling angle decreases, one edge of the web will take all the load, producing a risk of tearing (see Figure 11-20).

- m. Synthetic-web slings, other than those described in this section [i.e., polyester round and kevlar fiber (yarn) slings], shall be used in accordance with the sling manufacturer's recommendation.

- n. Conventional three-strand natural or synthetic fiber rope slings are **NOT** recommended for lifting service and should be used only if conventional sling types are not suitable for a unique application. The requirements of ASME B30.9 ("Slings"), Section 9-4, and 29 CFR 1910.184(h) shall be followed.

**CAUTION:** Tiedown and/or ratchet strap shall not be used as synthetic-web slings. Only synthetic-web slings constructed from webbing approved for sling construction by the manufacturer or other qualified person shall be used at DOE locations.

### 11.3.5.1 Inspections

- a. Users of synthetic-web sling shall visually inspect all slings before each use.

- b. Annual inspection shall be made by a qualified inspector, and inspection records shall be kept on file and readily available.

- c. When it is necessary to use a nylon or polyester sling in a radiation area, the responsible manager shall ensure that radiation exposure does not exceed 100,000 rad during the life of the sling.

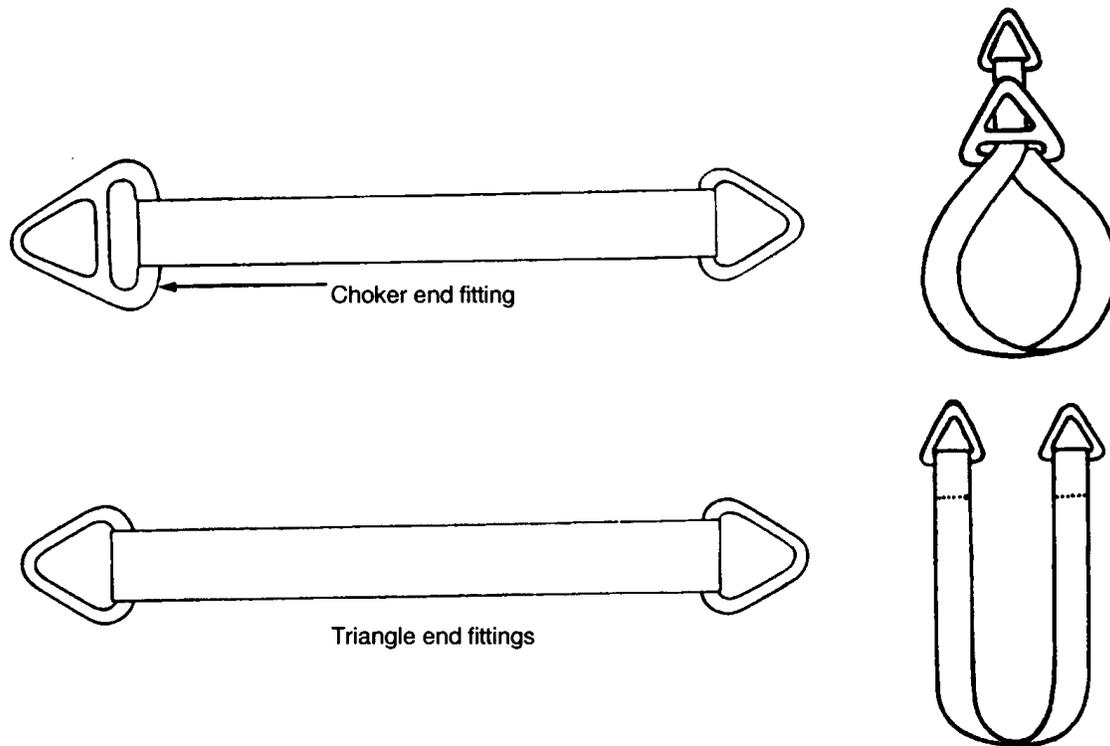
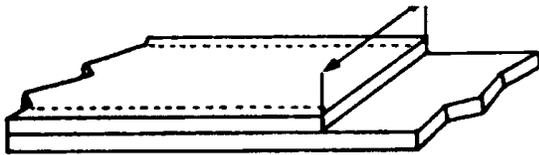
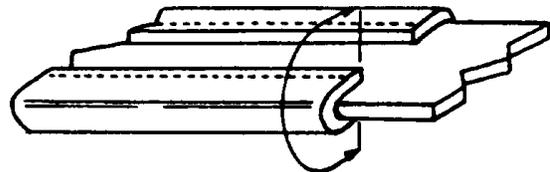


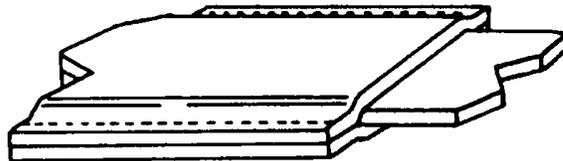
Figure 11-18. Metal end fittings.



**REGULAR.** This is the type of edge protection that is sewn on to give fixed protection at expected wear points. They can be sewn anywhere on the sling, at any length on one side, or on both sides.



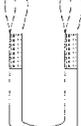
**EDGE GUARD.** A strip of webbing or leather is sewn around each edge of the sling. This is necessary for certain applications where the sling edges are subject to damage.



**SLEEVE.** Sometimes called sleeve or sliding-tube type wear pads, these pads are ideal for handling material with sharp edges because the sleeve does not move when the sling stretches and adjusts to the load. Sleeves cover both sides of the sling and can be shifted to points of expected maximum wear.

Figure 11-19. Web and edge protectors.

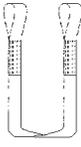
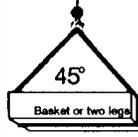
**Table 11-14. Load capacity of synthetic web slings in pounds Design Factor = 5:1  
(eye and eye, twisted eye, triangle fittings, choker fittings)**

Web width (in.)	 Vertical	 Choker	 Basket or two legs	 60° Basket or two legs	 45° Basket or two legs	 30° Basket or two legs	Web width (in.)
<b>Nylon Single Ply Web Slings (6,000 lb/in. material)</b>							
1	1,200	900	2,400	2,080	1,700	1,200	1
2	2,400	1,800	4,800	4,160	3,400	2,400	2
3	3,600	2,700	7,200	6,240	5,100	3,600	3
4	4,800	3,600	9,600	8,300	6,800	4,800	4
5	6,000	4,500	12,000	10,400	8,500	6,000	5
6	7,200	5,400	14,400	12,500	10,200	7,200	6
<b>Nylon Double Ply Web Slings (6,000 lb/in. material)</b>							
1	2,400	1,800	4,800	5,600	3,400	2,400	1
2	4,800	3,600	9,600	8,320	6,800	4,800	2
3	7,200	5,400	14,400	12,480	10,200	7,200	3
4	9,600	7,200	19,200	16,600	13,600	9,600	4
5	12,000	9,000	24,000	20,800	17,000	12,000	5
6	14,400	10,800	28,800	25,000	20,400	14,400	6

(CFR 1910.184/ANSI/ASME B30.9)

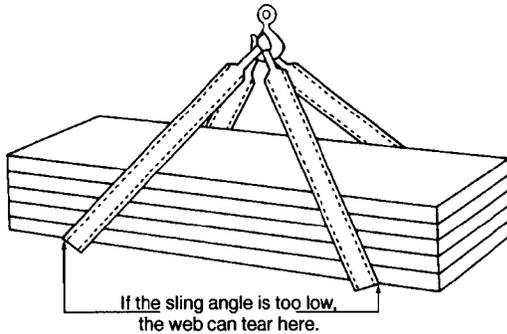
- (1) For an endless sling with vertical hitch carrying a load of such size as to throw the legs more than 5 deg. off vertical use rated load data for eye and eye sling, basket hitch and corresponding leg angles.
- (2) Follow manufacturer's capacities, they vary from manufacturer to manufacturer.
- (3) Choker hitch values apply only to choke angles greater than 120 degrees.

**Table 11-15. Load capacity of synthetic web slings in pounds Design Factor = 5:1  
(eye and eye, twisted eye, triangle fittings, choker fittings)**

Web width (in.)	 Vertical	 Choker	 Basket or two legs	 60° Basket or two legs	 45° Basket or two legs	 30° Basket or two legs	Web width (in.)
<b>Nylon Single Ply Web Slings (9,000 lb/in. material)</b>							
1	1,600	1,280	3,200	2,770	2,260	1,600	1
2	3,200	2,560	6,400	5,540	4,520	3,200	2
3	4,800	3,840	9,600	8,320	6,780	4,800	3
4	6,400	5,120	12,800	11,090	9,040	6,400	4
5	8,000	6,400	16,000	13,860	11,300	8,000	5
6	9,600	7,680	19,200	16,640	13,560	9,600	6
<b>Nylon Double Ply Web Slings (9,000 lb/in. material)</b>							
1	3,200	2,560	6,400	5,540	4,520	3,200	1
2	6,400	5,120	12,800	11,090	9,040	6,400	2
3	8,880	7,100	17,760	15,390	12,540	8,880	3
4	11,520	9,210	23,040	19,660	16,270	11,520	4
5	14,000	11,200	28,000	24,260	19,775	14,000	5
6	16,320	13,050	32,640	28,280	23,050	16,320	6

(CFR 1910.184/ANSI/ASME B30.9)

- (1) For an endless sling with vertical hitch carrying a load of such size as to throw the legs more than 5 deg. off vertical use rated load data for eye and eye sling, basket hitch and corresponding leg angles.
- (2) Follow manufacturer's capacities, they vary from manufacturer to manufacturer.
- (3) Choker hitch values apply only to choke angles greater than 120 degrees.



**Figure 11-20. Effect of low sling angle.**

d. Slings shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.
2. Melting or charring of any part of the surface.
3. Snags, punctures, tears, or cuts.
4. Broken or worn stitches.
5. Wear or elongation exceeding the amount recommended by manufacturers.
6. Distortion of fittings.

A sample periodic inspection form is included as Exhibit III at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

### 11.3.5.2 Proof-Testing

a. When specified by the purchaser, web slings of all types shall be certified as having been proof-tested prior to initial use.

1. The proof load for single-leg slings and endless slings shall be 200 percent of the vertical rated capacity.

2. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

b. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either

certification by the manufacturer or a pull test certified by a qualified person is acceptable.

### 11.3.5.3 Operation

The following shall apply to all personnel who use synthetic-web slings:

- a. Determine the weight of the load.
- b. Select a sling having suitable characteristics for the type of load, hitch, and environment.
- c. Ensure that slings with end fittings that are used in a choker hitch have sufficient length so that the choking action is on the body of the sling.
- d. In slings used in a basket hitch, balance the load to prevent slippage.
- e. Do not drag slings across the floor or over any abrasive surface.
- f. Do not twist or tie slings into knots.
- g. Protect slings from being cut by sharp corners, sharp edges, and highly abrasive surfaces.
- h. Do not pull slings from under loads when a load is resting on a sling.
- i. Do not use synthetic-web slings to lift loads in excess of the rated capacity, properly derated for other than straight-pull configuration.
- j. Store synthetic-web slings to prevent mechanical or chemical damage.
- k. Do not use nylon slings where acid conditions exist.
- l. Do not use polyester and polypropylene slings where caustic conditions exist.
- m. Do not use polyester and nylon slings at temperatures in excess of 180 degrees F (82 degrees C), nor polypropylene slings at greater than 200 degrees F (93 degrees C).
- n. Do not use aluminum fittings where acid or caustic fumes, vapors, sprays, mists or liquids are present.
- o. Ensure that each sling is permanently marked to show:
  1. Name or trademark of manufacturer.

2. Manufacturer's code or stock number. above due to security classification of the loads to be lifted or for other valid reasons approved by the responsible manager.
3. Rated capacity for types of hitches used. p. Ensure that synthetic-web slings are marked with the inspection due date. This information may be stenciled or stamped on a metal tag affixed to the sling.
4. Type of synthetic-web material.

NOTE: Slings may be marked with a serial number or other identifying number that can be used to determine capacity in situations where it becomes impossible to mark the sling as described

Exhibits I through III are intended to be sample forms only and are not mandatory. Any other form that accomplishes the purpose is acceptable.

EXHIBIT I

RIGGING TACKLE ANNUAL INSPECTION  
(WIRE-ROPE SLINGS)

INSPECTOR \_\_\_\_\_

INSPECTION DATE \_\_\_\_\_

- NOTES:**
1. Qualified inspector shall witness and verify all steps below.
  2. Proof-test to 200% of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

Wire rope shall be immediately removed from service if any of the following conditions are present:

INSPECTION

- \_\_\_\_\_ 1. Ten randomly distributed broken wires in one rope lay or five broken wires in one strand in one rope lay.
- \_\_\_\_\_ 2. Wear or scraping of 1/3 the original diameter of the outside individual wire.
- \_\_\_\_\_ 3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the wire-rope structure.
- \_\_\_\_\_ 4. Heat damage.
- \_\_\_\_\_ 5. Cracked, deformed, or worn end attachments.
- \_\_\_\_\_ 6. Hooks that are cracked or opened more than 15% of normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.
- \_\_\_\_\_ 7. Corrosion of the rope or end attachments.

Size: (Length, Diameter, Etc.) \_\_\_\_\_ Capacity (SWL) \_\_\_\_\_

Actual Load Test \_\_\_\_\_ lb

REMARKS \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Qualified inspector shall inspect hook by visual examination, liquid penetrant examination, or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

NDT INSPECTION OF HOOKS/RINGS, ETC. \_\_\_\_\_

QUALIFIED INSPECTOR \_\_\_\_\_ DATE \_\_\_\_\_

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## EXHIBIT II

RIGGING TACKLE ANNUAL INSPECTION  
(CHAIN)

INSPECTOR \_\_\_\_\_ INSPECTION DATE \_\_\_\_\_

- NOTES:**
1. Qualified inspector shall witness and verify all steps below.
  2. Proof-test to 200% of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, + 0% of the stipulated values.

## INSPECTION

- \_\_\_\_\_ 1. Hang chain in a vertical position, if practical, for preliminary inspection. Chain should hang reasonably straight if links are not distorted.
- \_\_\_\_\_ 2. Accurately measure the reach (inside of crane ring to inside of hook) under no load when new and at each inspection, and keep a record of increase in length.
- \_\_\_\_\_ 3. Check for localized stretch and wear. Lift each link from its seat and visually inspect for grooving. If grooving is noticed, verify stock diameter of links to be within the minimum safe dimension in the table below.
- \_\_\_\_\_ 4. Sharp transverse nicks should be rounded out by grinding.
- \_\_\_\_\_ 5. Check for evidence of heat damage.

Chain slings shall be immediately removed from service if any of the following conditions are present:

- a. Cracked or deformed master links, coupling links, etc.
- b. Hooks that are cracked or opened more than 15% of normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.
- c. Wear at any point of any chain link exceeding that shown in the table below.

**Table 11-11. Maximum allowable wear at any point of link.**

Chain size (in.)	Maximum allowable wear (in.)
1/4	3/64
3/8	5/64
1/2	7/64
5/8	9/64
3/4	10/64
7/8	11/64
1	12/64
1-1/4	16/64

NOTE: For other sizes, consult chain or sling manufacturer.

**EXHIBIT II (continued)**

RIGGING TACKLE ANNUAL INSPECTION  
(CHAIN)

Size & Length \_\_\_\_\_ Actual Load Test \_\_\_\_\_ Capacity (SWL) \_\_\_\_\_

Remarks \_\_\_\_\_

\_\_\_\_\_  
Qualified inspector shall inspect hook by visual examination, liquid penetrant examination, or magnetic particle examination.

Nondestructive test inspection of hooks/rings, etc. \_\_\_\_\_

QUALIFIED INSPECTOR \_\_\_\_\_ DATE \_\_\_\_\_

EXHIBIT III

RIGGING TACKLE PERIODIC INSPECTION  
(SYNTHETIC-WEB SLINGS)

INSPECTOR \_\_\_\_\_ INSPECTION DATE \_\_\_\_\_  
\_\_\_\_\_

- NOTES:**
1. Proof test to 200% of rated capacity to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, + 0% of the stipulated values.
  2. Qualified inspector shall witness all steps below.

Synthetic-web slings shall be immediately removed from service if any of the following conditions are present that would give doubt to the integrity of the sling:

- \_\_\_\_\_ a. Acid or caustic burns
- \_\_\_\_\_ b. Melting or charring of any part of the sling surface
- \_\_\_\_\_ c. Snags, punctures, tears, or cuts
- \_\_\_\_\_ d. Broken or worn stitches
- \_\_\_\_\_ e. Distortion of fittings
- \_\_\_\_\_ f. Wear or elongation exceeding manufacturer's recommendation.

TYPE: Web Sling \_\_\_\_\_

SIZE: (Length, Diameter, Etc.) \_\_\_\_\_ Capacity (SWL) \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

REMARKS: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

QUALIFIED INSPECTOR \_\_\_\_\_ DATE \_\_\_\_\_

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# CHAPTER 12

## RIGGING ACCESSORIES

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This chapter provides requirements for rigging accessories used in hoisting and rigging—shackles, eyebolts, rings, wire-rope clips, turnbuckles, rigging hooks, and load-indicating devices.

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## 12.1 GENERAL

a. The information presented in this chapter provides guidance for safely handling lifted loads. Diagrams are used to illustrate hoisting and rigging principles and good and bad rigging practices. This is not a rigging textbook; the information should be applied only by qualified riggers.

b. Rigging accessories that have been damaged or removed from service shall be made unusable for hoisting and rigging operations before being discarded.

c. Load tables are representative only and are not exact for all materials or all manufacturers.

d. Determine the weight of the load:

1. From markings on the load.
2. By weighing, if the load is still on the truck or railroad car.
3. From drawings or other documentation.
4. By calculation, using the load dimensions and the weights of common materials in Table 12-1.

e. Determine the center of gravity of the load as accurately as possible:

1. From drawings or other documentation.
2. From markings on the load.
3. By calculation.

f. Determine the best method to attach the load and select the lifting devices (e.g., eyebolts or shackles).

### 12.1.1 Inspections

a. The operator or other designated person shall visually inspect rigging accessories at the beginning of each work shift or prior to use for the following (records not required):

1. Wear.
2. Corrosion.

3. Cracks.
4. Nicks and gouges.
5. Distortion such as bending or twisting.
6. Evidence of heat damage from any cause.

b. A designated person shall determine whether conditions found during the inspection constitute a hazard and whether a more detailed inspection is required.

c. Rigging accessories having any of the following conditions shall be removed from service:

1. Cracks.
2. Distortion or deformation exceeding 15 percent of new conditions.
3. Any sign of incipient failure in shear for shackle pins.
4. Wear exceeding 10 percent of original dimensions.
5. Excessive corrosion.
6. Shackles not marked according to Section 12.3, "Shackles."
7. Heat damage.

d. A designated person shall perform nondestructive examinations according to applicable ASTM standards when needed by the responsible line manager or that person's authorized representative.

e. A sample load test and inspection form is included as Exhibit I at the end of this chapter. This form is a sample only and is not intended to be mandatory.

Table 12-1. Weights of common materials.

Name of metal	Weight (lb/ft <sup>3</sup> )	Name of material	Weight (lb/ft <sup>3</sup> )
Aluminum	166	Bluestone	160
Antimony	418	Brick, pressed	150
Bismuth	613	Brick, common	125
Brass, cast	504	Cement, Portland (packed)	100–120
Brass, rolled	523	Cement, Portland (loose)	70–90
Copper, cast	550	Cement, slag (packed)	80–100
Copper, rolled	555	Cement, slag (loose)	55–75
Gold, 24-carat	1,204	Chalk	156
Iron, cast	450	Charcoal	15–34
Iron, wrought	480	Cinder concrete	110
Lead, commercial	712	Clay, ordinary	120–150
Mercury, 60 degrees F	846	Coal, hard, solid	93.5
Silver	655	Coal, hard, broken	54
Steel	490	Coal, soft, solid	84
Tin, cast	458	Coal, soft, broken	54
Uranium	1,163	Coke, loose	23–32
Zinc	437	Concrete or stone	140–155
<u>Name of wood</u>		Earth, rammed	90–100
Ash	35	Granite	165–170
Beech	37	Gravel	117–125
Birch	40	Lime, quick (ground loose)	53
Cedar	22	Limestone	170
Cherry	30	Marble	164
Chestnut	26	Plaster of paris (cast)	80
Cork	15	Sand	90–106
Cypress	27	Sandstone	151
Ebony	71	Shale	162
Elm	30	Slate	160–180
Fir, Balsam	22	Terra-cotta	110
Hemlock	31	Traprock	170
Maple, Oak	62	Water	65
Pine, Poplar	30		

## 12.1.2 Testing

- a. Tackle assemblies, handling fixtures, and rigging accessories for critical-lift service shall have an initial proof-load test of 2 times the rated capacity. If proof-testing cannot be verified, the tackle shall be proof-tested before being used to make a critical lift.
- b. Tackle assemblies, handling fixtures, and rigging accessories shall be tested as a unit when practical. When necessary, parts of such assemblies may be tested individually with the approval of the inspector.
- c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values.
- d. All parts showing damage or permanent deformation as a result of load-testing shall be replaced. Replacement parts shall be load-tested in accordance with this paragraph. Discarded parts shall be destroyed.

- e. Multileg lift assemblies shall be load-tested based on any two legs sharing the entire load. Attach legs not undergoing test in a manner to ensure that load stability is not lost during the test.

- f. Dynamometers and load cells shall be tested and calibrated at least once a year and when specified in the critical lift procedure before being used to make a critical lift. This also applies if they have not been used in the previous 6 months. All calibrated devices shall have a tag affixed indicating date of calibration, by whom they were calibrated, and the date that the next calibration is due.

## 12.1.3 Good and Bad Rigging Practices

Figure 12-1 illustrates some good and bad rigging practices.

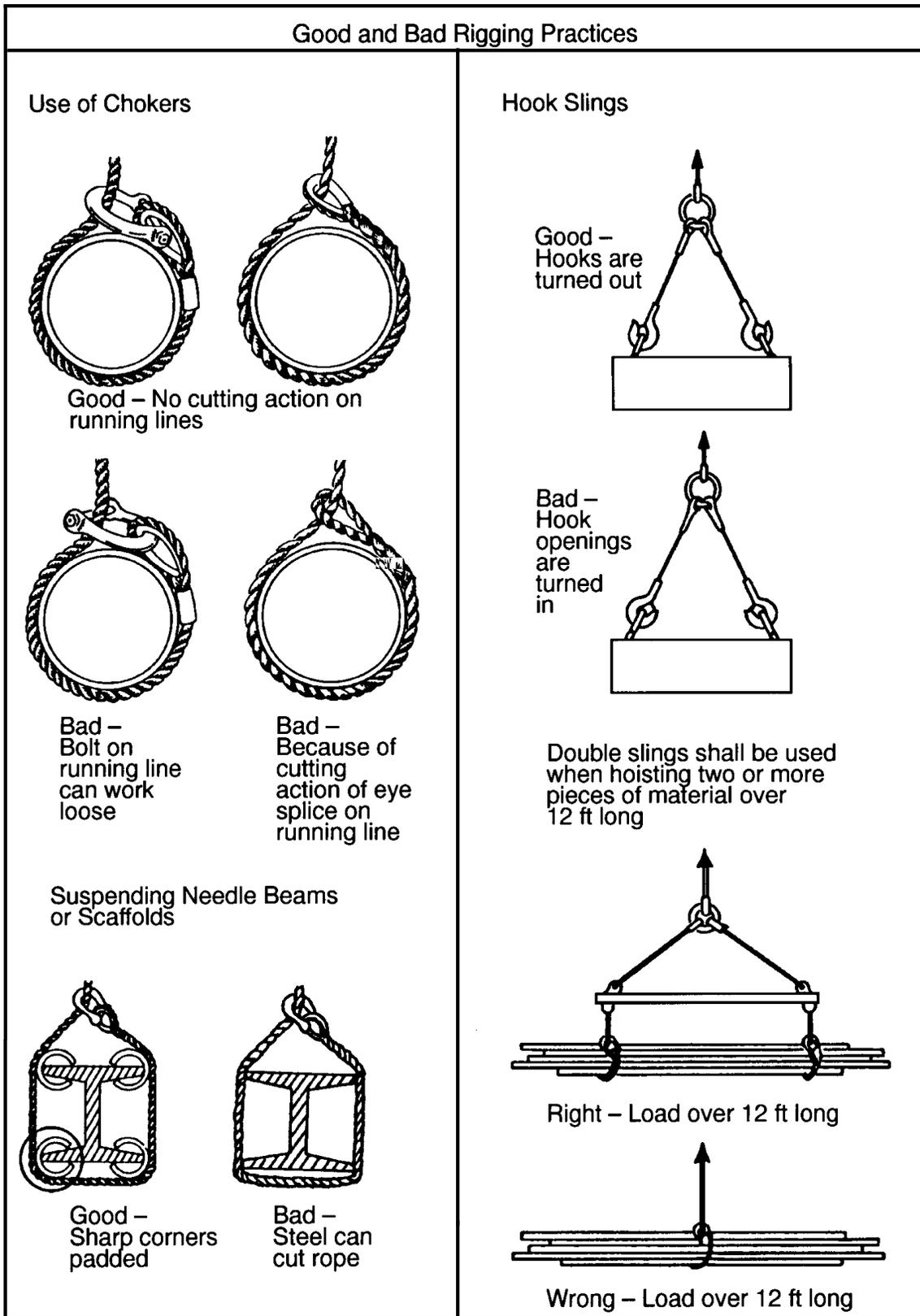


Figure 12-1. Good and bad rigging practices.

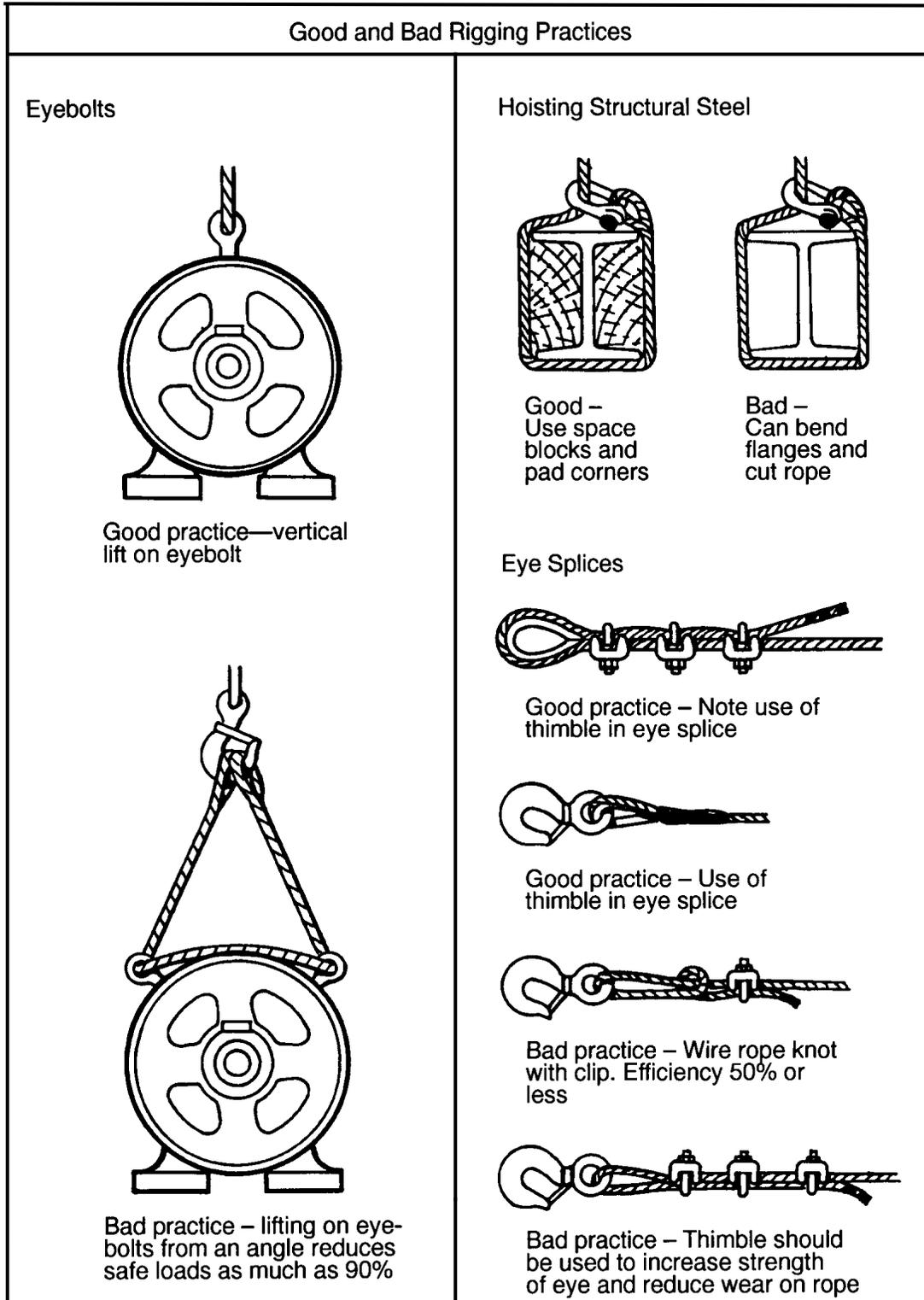


Figure 12-1. (continued).

## 12.2 RIGGING HOOKS

### 12.2.1 Design

- a. Hook design shall meet generally accepted hook design standards and be compatible with the requirements of ASME B30.10, Chapter 10-2, “Hook—Miscellaneous” (see Chapter 13, “Load Hooks,” for equipment load hook requirements.)
- b. Latch-equipped hooks shall be used unless the application makes the use of the latch impractical or unnecessary.

### 12.2.2 Marking

The manufacturer's identification shall be forged, cast, or die-stamped on a low-stress and nonwearing area of the hook.

### 12.2.3 Construction

- a. The hook material shall have sufficient ductility to permanently deform before failure at the temperature at which the hook will be used.
- b. Rated capacities for hooks shall equal or exceed the rated capacity of the chain, wire rope, or other suspension members to which they are attached.

### 12.2.4 Load Limits

A hook shall not be loaded beyond its rated capacity, except as is necessary to conform to the requirements for load testing of the sling or hardware to which it is attached. See Table 12-2 for hook capacity.

### 12.2.5 Inspections

#### 12.2.5.1 Initial Inspection

- a. A qualified inspector shall inspect all new and repaired hooks prior to initial use to ensure compliance with the applicable provisions of ASME B30.10 Section 10-2.2. Dated and signed inspection records shall be kept on file and shall be readily available.
- b. Inspection procedure and recordkeeping requirements for hooks in regular service shall be determined by the kind of equipment in which they are used. When such requirements for hooks are stated in standards for the specific equipment, they shall take precedence over the requirements

of this section.

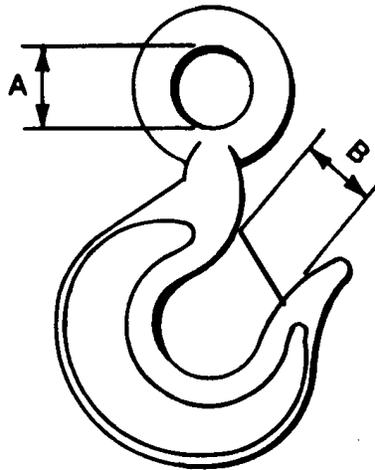
#### 12.2.5.2 Daily Inspection

- a. The operator or other designated person shall visually inspect hooks daily or prior to first use, if the hook is not in regular service, for the following (records are not required):
  1. Cracks, nicks, gouges.
  2. Deformation.
  3. Damage from chemicals.
  4. Damage, engagement, or malfunction of latch (if provided).
  5. Evidence of heat damage.
- b. A designated person shall examine deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

#### 12.2.5.3 Frequent Inspection

- a. The operator or other designated personnel shall visually inspect the hook at the following intervals (records are not required):
  1. Normal service—monthly.
  2. Heavy service—weekly to monthly.
  3. Severe service—daily to weekly.
- b. Hook service is defined as follows:
  1. Normal service—operation at less than 85 percent of rated capacity except for isolated instances.

Table 12-2. Strength of standard sling hooks.



Standard hook number	Inside diameter of Eye A (in.)	Throat Opening B (in.)	Rated capacity (tons)
22	3/4	1	0.5
23	7/8	1 1/16	0.6
24	1	1 1/8	0.7
25	1 1/8	1 1/4	1.2
26	1 1/4	1 3/8	1.7
27	1 3/8	1 1/2	2.1
28	1 1/2	1 3/4	2.5
29	1 5/8	1 7/8	3.0
30	1 3/4	2 1/16	4.0
31	2	2 1/4	4.7
32	2 3/8	2 1/2	5.5
33	2 3/4	3	6.8
34	3 1/8	3 3/8	8.0
34 <sup>a</sup>	3 1/4	3 5/8	10.0
35	3 1/2	4	11.0
36	4	4 1/2	20.0
38	4 1/2	5	30.0

**Notes:**

a. The above values are for "Vulcan" and similarly designed standard hooks.

b. The capacity can be found by the diameter of the hole in the eye of the hook. If the throat opening of any hook exceeds the dimension given above the corresponding diameter of the eye, the hook has been overstrained and must not be used.

2. Heavy service—operation at 85 to 100 percent of rated capacity as a regular specified procedure.

3. Severe service—operation at heavy service coupled with abnormal operating conditions.

c. These inspections shall, in addition to the requirements of Section 12.2.5.2, “Daily Inspections,” include the following:

1. Wear.
2. Hook attachment and securing means.

d. A designated person shall examine deficiencies and determine whether a more detailed inspection is required.

#### 12.2.5.4 Periodic Inspection

a. A qualified inspector shall perform a complete inspection at the following intervals:

1. Normal service—yearly.
2. Heavy service—semiannually.
3. Severe service—quarterly.

b. A qualified inspector shall examine deficiencies and determine whether they constitute a safety hazard.

c. The inspection shall include the requirements of Section 12.2.5.3, “Frequent Inspection.”

d. Hooks shall receive a nondestructive examination according to applicable ASTM standards annually.

e. Hooks having any of the following conditions shall be removed from service until repaired or replaced:

1. Deformation—Any bending or twisting exceeding 10 degrees (or as recommended by the manufacturer) from the plane of the unbent hook.

2. Throat opening—Any distortion causing an increase in throat opening exceeding 15 percent (or as recommended by the manufacturer).

3. Wear—Any wear exceeding 10 percent (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

4. Cracks.

f. If a latch is provided and it becomes inoperative because of wear or deformation or fails to fully bridge the throat opening, the hook shall be removed from service until the device has been repaired or replaced and the throat opening has been determined not to exceed 15 percent (or as recommended by the manufacturer).

g. Dated and signed inspection records shall be kept on file and shall be readily available.

### 12.2.6 Testing

a. Hooks not attached to slings or other lifting hardware shall be proof tested to 200 percent of the rated capacity prior to initial use. The test load shall be accurate to within -5 percent, +0 percent of stipulated values.

b. No performance testing of hooks shall be required, except as is necessary to conform to the requirements for the slings or rigging hardware of which they are a part.

### 12.2.7 Maintenance

a. A designated person shall repair cracks, nicks, and gouges by grinding longitudinally, following the contour of the hook, provided that no dimension is reduced more than 10 percent of its original value (or as recommended by the manufacturer).

b. All other repairs shall be performed by the manufacturer.

### 12.2.8 Operation

The following shall apply to rigging hook users:

- a. Determine that the load or force required does not exceed the rated capacity of the hook's assembly, especially when considering special conditions such as choking or grabbing.

- b. Avoid shock loading.

- c. Keep hands, fingers, and body from getting between the hook and the load.

---

## 12.3 SHACKLES

---

a. Shackles are made of drop-forged steel bent into shape. They are strong, closed attachments that will not come unhooked. The size is specified by the diameter of the body. Avoid side pulls on the shackle body.

b. Shackle pins should fit free without binding. Do not substitute a bolt for the shackle pin. Figure 12-2 shows shackles and provides examples of good and bad practices and inspection points.

c. Each shackle body shall be permanently and legibly marked by the manufacturer. Raised or

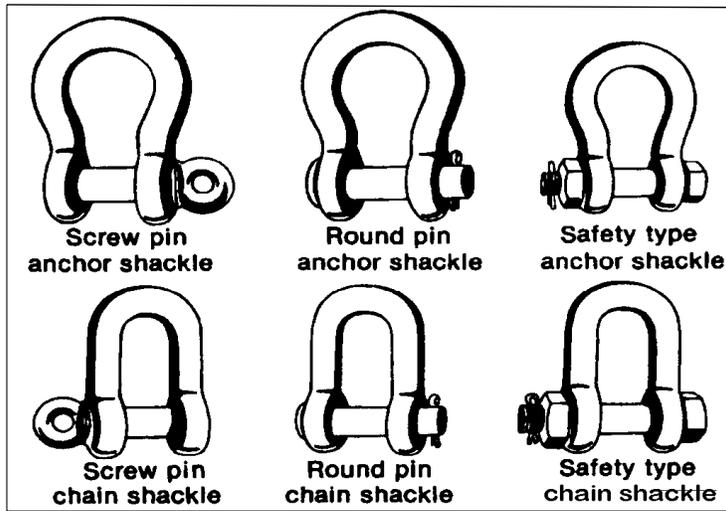
stamped letters on the side of the bow shall be used to show:

1. Manufacturer's name or trademark.
2. Size.
3. Rated capacity.

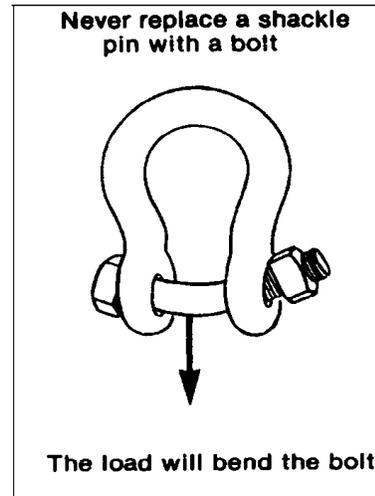
d. Shackles that are not properly marked shall be permanently removed from service.

e. When shackles are used at load angles other than 90 degrees, the safe-load rating shall be reduced accordingly.

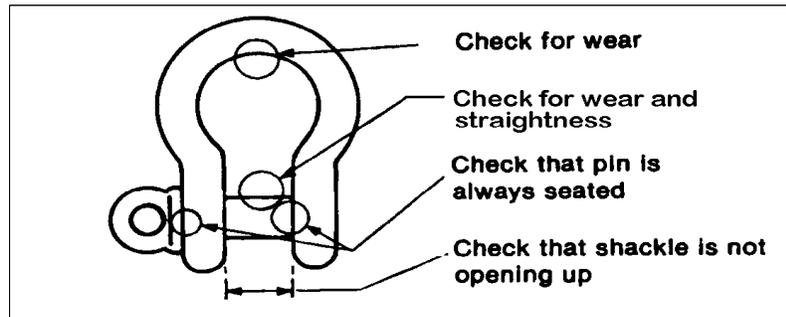
**Typical shackles**



**Replacing shackle pins**



**Shackle inspection areas**



Do not use screw pin shackles if the pin can roll under load and unscrew

**Eccentric shackle loads**

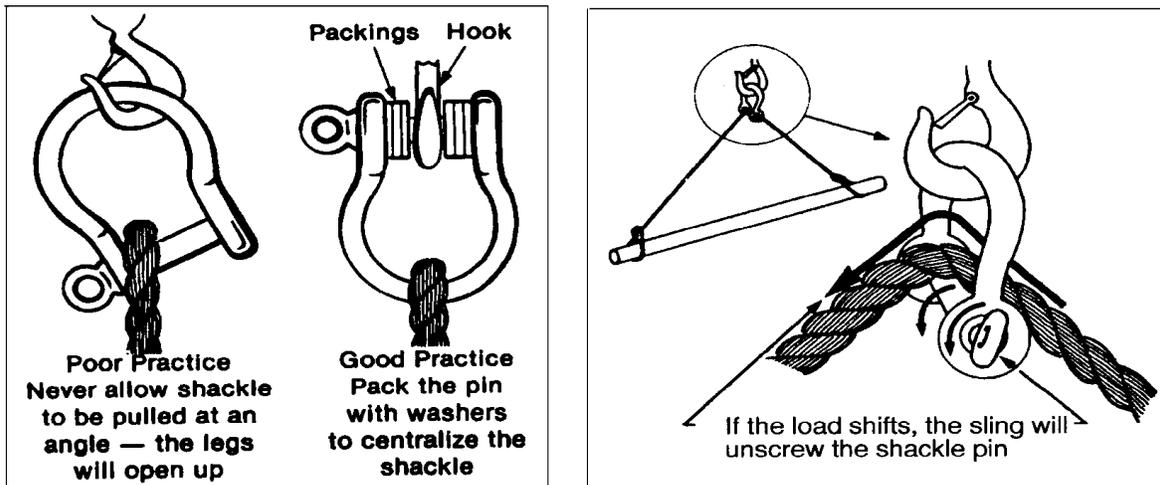


Figure 12-2. Shackles.

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## 12.4 EYEBOLTS

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- a. Eyebolts used for hoisting shall be fabricated from forged carbon or alloy steel.
- b. Eyebolts shall have a minimum design factor of 5:1. The vertical safe-working load shall be forged, stamped, or inscribed into each eyebolt by the manufacturer or the owner. A permanently attached metal tag bearing the same information may also be used.
- c. Eyebolts shall have Class II fit and have a minimum of one-and-one-half diameters thread engagement. Nuts on through-eyebolts shall be self-locking or shall be secured with lock wires or other suitable means to prevent loosening.
- d. The following shall apply to eyebolt users:
  - e. Use shouldered eyebolts for all applications, except where it is not possible due to the configuration of the item to be lifted. See Figure 12-3. When unshouldered eyebolts are used, do not use nuts, washers, and drilled plates to make shouldered eyebolts.
  - f. Do not use wire-type or welded eyebolts in DOE-lifting operations.
  - g. Ensure shoulders seat snugly against the surface on which they bear.
  - h. Spacers may be used, if necessary, to ensure proper seating of the eyebolt. Use a flat spacer no thicker than 1/16 of the outside diameter and approximately the same diameter as the maximum axis of the eyebolt shoulder with the smallest inside diameter that will fit the eyebolt shank.
  - i. Spot-face or slightly counterbore the surface of the item to which the eyebolt is fastened to the minimum depth needed for cleanup of the surface and complete bearing of the shoulder or spacer on the bearing surface.
  - j. Carefully inspect each eyebolt before use. Visually inspect the hole to ensure that there has been no deformation. Check the condition of the threads in the hole to ensure that the eyebolt will secure and the shoulder can be brought down snug. Destroy eyebolts that are cracked, bent, or have damaged threads.
  - k. Ensure that the shank of the eyebolt is not undercut and is smoothly radiused into the plane of the shoulder or the contour of the ring for nonshouldered eyebolts.
  - l. When more than one eyebolt is used in conjunction with multiple-leg rigging, spreader bars, lifting yokes, or lifting beams should be used to eliminate angular lifting. However, where spreaders, yokes, or beams cannot be used, eyebolts may be used for angular lifting, provided that the limiting conditions in Table 12-3 are considered. An angular lift is any lift in which the lifting force is applied at any angle to the centerline of the shank of the eyebolt.
  - m. Where nonshouldered eyebolts must be used for a critical lift, ensure that an engineering analysis of the loading and load vectors is made and approved before use. Minimize the angle between the sling and the eyebolt axis. In no case shall the eyebolt loading exceed the values shown in Table 12-3.

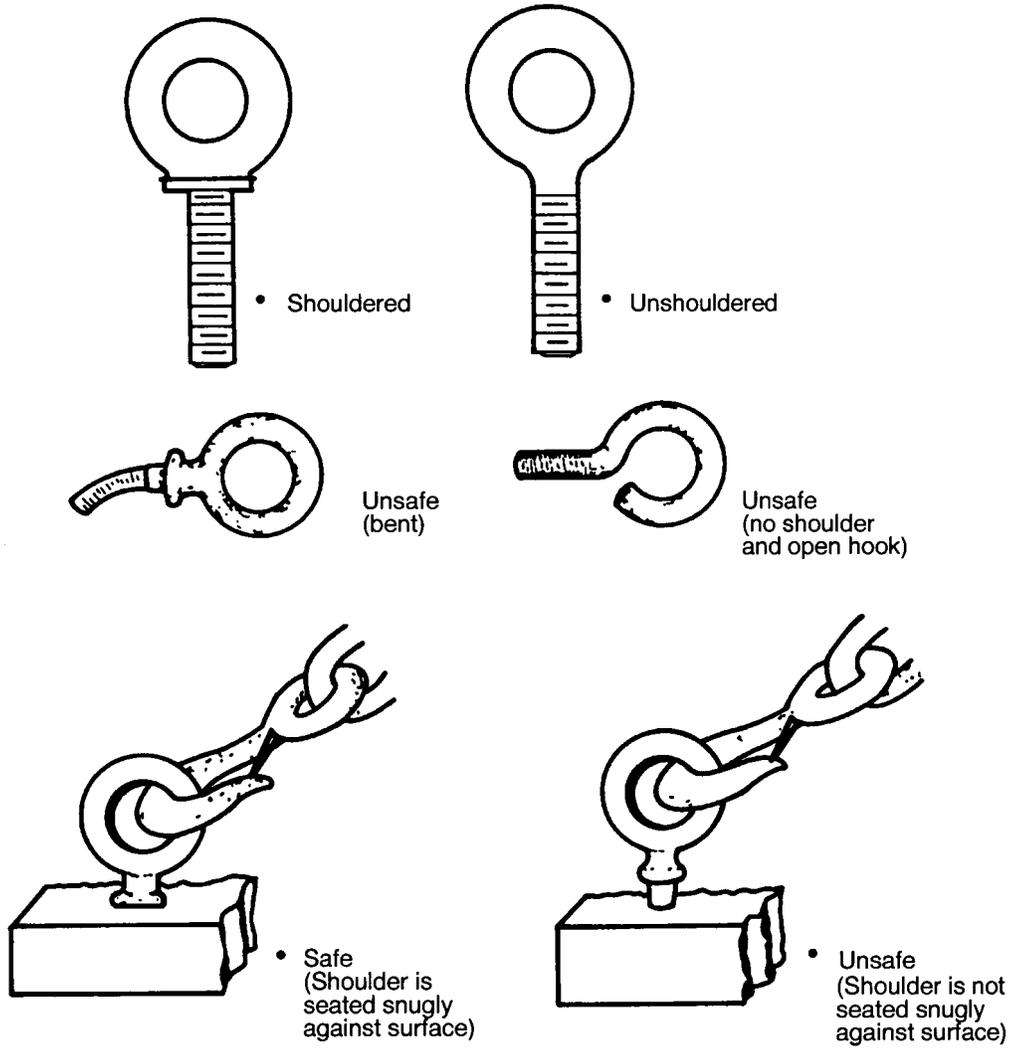
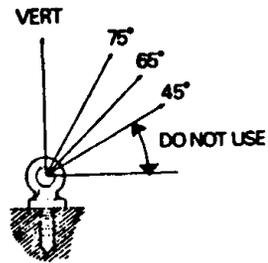


Figure 12-3. Eyebolts.

**Table 12-3. Safe loading of eyebolts.**

<p style="text-align: center;"><b>EYEBOLTS</b>                      — Shoulder Type Only                      — Forged Carbon Steel</p> 					
Stock diameter (in.)	SAFE WORKING LOADS CORRESPONDING TO ANGLE OF PULL				
	Vertical	75 degrees	60 degrees	45 degrees	Less than 45 degrees
1/4	500	Reduce vertical loads by 45%	Reduce vertical loads by 65%	Reduce vertical loads by 75%	NOT RECOMMENDED
5/16	800				
3/8	1,200				
1/2	2,200				
5/8	3,500				
3/4	5,200				
7/8	7,200				
1	10,000				
1 1/4	15,200				
1 1/2	21,400				

Note: The safe working loads for plain (shoulderless) eyebolts is the same as for shoulder bolts under vertical load. Angular loading is not recommended.

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## 12.5 TURNBUCKLES

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a. Turnbuckles may be used in sling systems provided that they are engineered, designed, and approved as a part of the sling system. Approved turnbuckles shall be marked and identified for use with the sling set for which they were designed and shall be load-tested as part of the sling set. Before each use, turnbuckles shall be inspected for damage. Damaged threads, jamb nuts, or bent frame members make the unit unsuitable for use.

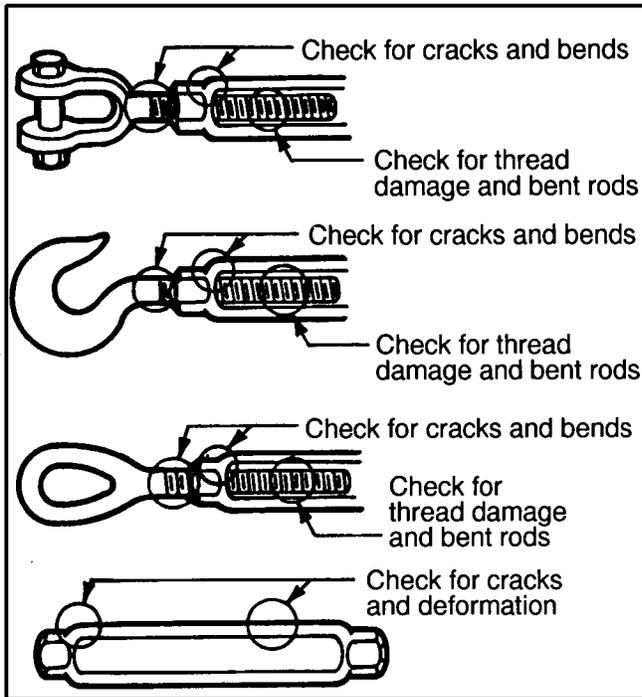
b. Jamb nuts or locking devices must be tightened or locked before making lifts with

turnbuckles. See Figure 12-4 for safe working load information and turnbuckle inspection areas.

c. Turnbuckles shall be fabricated from forged alloy steel and shall have a minimum design factor of 5:1.

d. Turnbuckles used in applications where there is vibration shall be secured to the frame with locks, pins, or wires to prevent turning or loosening.

Turnbuckle Inspection Areas



Turnbuckles

<ul style="list-style-type: none"> <li>Weldless Construction</li> <li>Forged Alloy Steel</li> </ul>		
End fitting, stock diameter (in.)	Safe working load (SWL) of any combination of jaw end fittings, eye end fittings, and stub end fittings (lb)	SWL of any turnbuckle having a hook end fitting (lb)
1/4	500	400
5/16	800	700
3/8	1,200	1,000
1/2	2,200	1,500
5/8	3,500	2,250
3/4	5,200	3,000
7/8	7,200	4,000
1	10,000	5,000
1 1/4	15,200	5,000
1 1/2	21,400	7,500
1 3/4	28,000	—
3	37,000	—
2 1/2	60,000	—
2 3/4	75,000	—

Turnbuckles

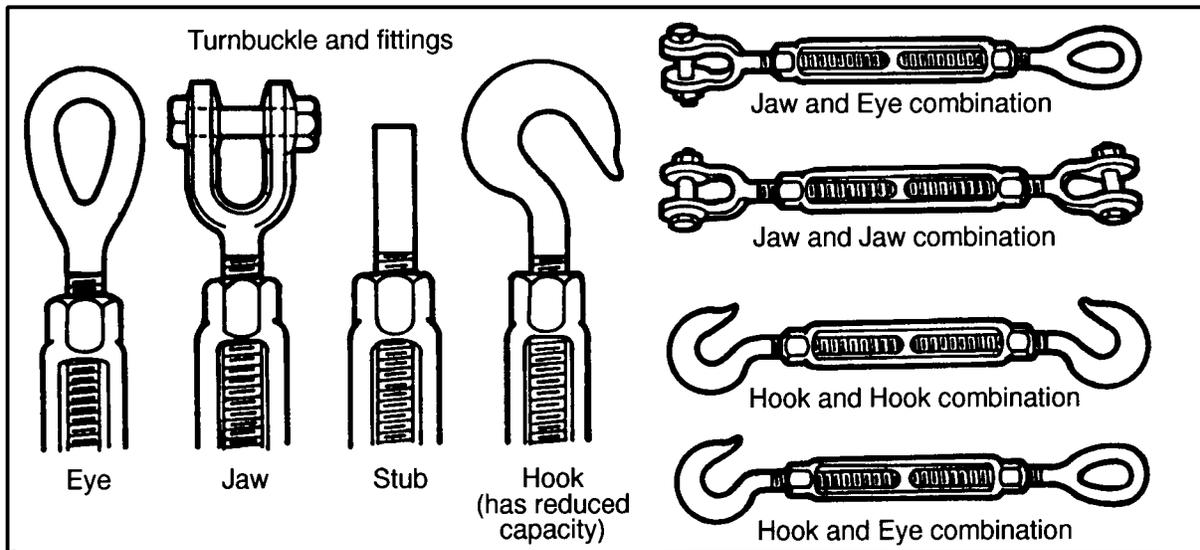


Figure 12-4. Turnbuckles.

## 12.6 LINKS AND RINGS

Links and rings are usually designed and manufactured as a part of the lifting hardware for a specific purpose, such as the peak link on multiple-leg slings. However, the rings and

links may also be found on the load-attachment end of slings. Figure 12-5 shows typical rings and links. Table 12-4 provides safe loads for weldless rings and links.

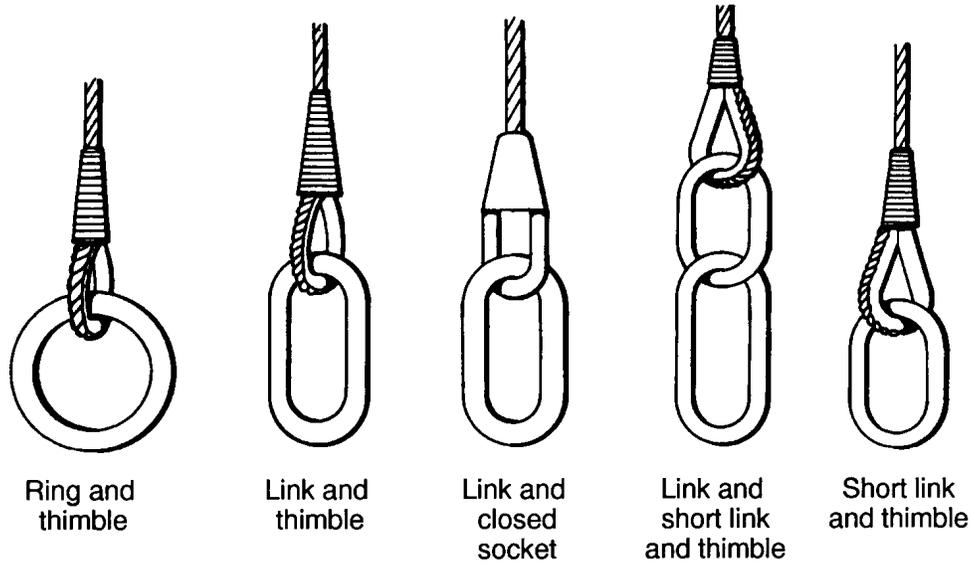


Figure 12-5. Rings and links.

Table 12-4. Safe loads for weldless rings and links.



## RINGS

Dimensions		Est. wt., each (lb)	Safe load, single pull (lb)
Diam., stock (in.)	Diam., inside (in.)		
7/8	4	2 3/4	7,200
7/8	5 1/2	3 1/2	5,600
1	4	3 5/8	10,800
1 1/8	6	6 1/2	10,400
1 1/4	5	7	17,000
1 3/8	6	10	19,000

## SLING LINKS

Diam., stock (in.)	Length, inside (in.)	Inside width, small end	Inside width, large end	Est. wt. per 100 (lb)	Safe load, single pull (lb)
3/8	2 1/2	3/8	1 1/4	23	1,800
1/2	3	1/2	1 5/8	50	3,200
*5/8	3 3/4	1 1/4	2 1/2	110	4,200
*3/4	4 1/2	1 1/2	3	190	6,000
*7/8	5 1/4	1 3/4	3 1/2	285	8,300
*1	6	2	4	430	10,800
1 1/4	6	1 1/4	3 3/4	700	22,000
*1 3/8	8 1/4	2 3/4	5 1/2	1125	20,500



\*Sizes of sling links denoted by the asterisk are new and have the larger inside dimensions needed for 2-leg slings.

## END LINKS



Diam., stock (in.)	Inside length (in.)	Inside width (in.)	Est. wt. per 100 (lb)	Suggested safe loads (lb)
5/16	1 3/4	1/2	14	2,500
3/8	1 7/8	9/16	21	3,800
1/2	2 3/8	3/4	48	6,500
5/8	3 1/4	1	92	9,300
3/4	3 1/2	1 1/8	137	14,000
7/8	5 1/8	2	275	12,000
1	5 1/8	2	360	17,000
1 1/4	6 7/16	2 1/4	700	28,000
1 3/8	7 3/4	2 3/4	1000	30,000

## 12.7 METAL-PLATE CLAMPS

- a. Metal-plate clamps are designed specifically for lifting metal plates. They may also be used for lifting fiber sheets. Their grip or hold is determined by the weight or pull of the load.
- b. The following applies to users of metal-plate clamps:
  - c. The plate shall be inserted all the way into the clamp to obtain a good grip. Ensure proper orientation of the clamp. See Figure 12-6.
  - d. Plate clamps are suitable for handling only one plate at a time.
  - e. Avoid side pulls on plate clamps.
  - f. Check plate clamps for wear in the jaws and for loose, worn, or broken parts.
  - g. Ensure that the rated capacity of each plate clamp is stamped on its body.

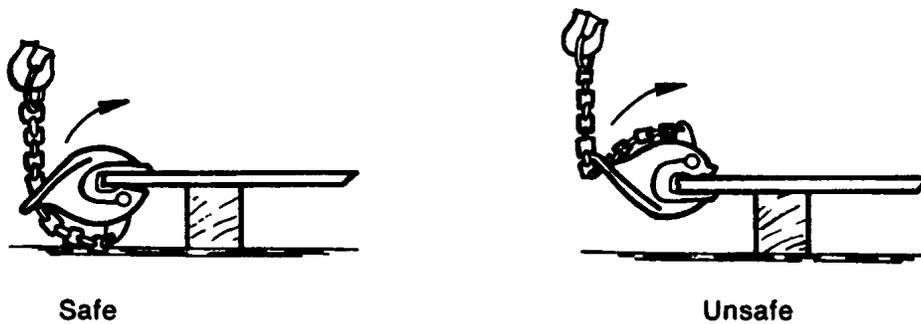


Figure 12-6. Metal-plate clamps.

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## 12.8 LOAD-INDICATING DEVICES

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a. Load-indicating devices are not required in routine operations where loads of known and essentially consistent weight are to be handled. Rather, load-indicating devices are required for use with loads of uncertain weight that could be within 90–100 percent of the rated capacity of the equipment or maximum working load of any part of the tackle. Use load-indicating devices where the equipment/ tackle configuration could result in binding or friction of the load that could cause a greater stress in the hoist or tackle than would result from the apparent hook load.

b. The accuracy of load-indicating devices shall depend on the requirements of the load system planned and shall not restrict the system requirements; an accuracy of 2 percent of full-scale reading within 10–70 percent of

instrument range is recommended. The device should be selected so that the estimated hook load lies between 10 and 70 percent of the instrument range.

c. Dynamometers commonly have design factors of less than 5:1. Any combination where the safety factor of the dynamometer times the capacity of the dynamometer divided by the load equals 5 is acceptable.

d. When dynamometers are used as load-bearing parts of rigging, they must be constructed to provide a measure of safety and reliability equal to that of the associated rigging, or a safety device must be installed to prevent dropping the load in the event of a failure.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

EXHIBIT I

RIGGING, TACKLE, ACCESSORIES LOAD TEST AND INSPECTION  
(HOOKS, SHACKLES, RINGS, ETC.)

INSPECTOR \_\_\_\_\_ INSPECTION DATE \_\_\_\_\_

**NOTES:** 1. Proof test to 200% of rated capacity for critical lift service to certify new equipment procured without manufacturer's certification. Test loads shall be accurate to within -5%, +0% of the stipulated values.

\_\_\_\_\_ 2. Qualified inspector shall witness all steps below.

\_\_\_\_\_ 3. Accept/reject data should be to manufacturer's specifications. Hooks, shackles, rings, and the like, shall be removed from service and discarded if any of the following conditions are present that would cause doubt of the integrity of the accessories:

A. Corrosion, damage, or undue wear

B. Cracks, twists, or significant change in openings

(1) 15% more than normal opening

(2) 10% twist more than normal from the plane of the unbent hook

(3) 10% wear

(4) 5% elongation of the hook shank.

C. Heat damage.

\_\_\_\_\_ 4. Shackles, rings, etc.

A. Wear, corrosion, spreading, and deformation

(1) 15% deformation of their new condition

(2) Shackle pins—any sign of incipient failure in shear.

Type \_\_\_\_\_ Size \_\_\_\_\_ Rated Capacity (SWL) \_\_\_\_\_

Tested to \_\_\_\_\_

Serial Numbers \_\_\_\_\_

Qualified inspector shall perform a nondestructive test by visual examination, liquid penetrant examination, or magnetic particle examination.

Acceptance: No cracks, linear indications, laps, or seams.

QUALIFIED INSPECTOR VERIFY \_\_\_\_\_ DATE \_\_\_\_\_

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# CHAPTER 13

## LOAD HOOKS

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This chapter provides safety standards for the inspection, testing, and maintenance of load hooks installed on cranes or hoists and implements the requirements of ASME B30.10, Chapter 10-1, “Hooks.” See Chapter 12, “Rigging Accessories,” for rigging hook requirements.

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## 13.1 GENERAL

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### 13.1.1 Marking

The manufacturer's identification shall be forged, cast, or die-stamped on a low-stress and nonwearing area of the hook.

### 13.1.2 Attachments

a. Hoisting hooks shall be fitted with a latch to bridge the throat opening to prevent the accidental release of slings or attachments. Hooks without latches may be used in special applications where the latch would interfere with the proper use of the hook, providing that (1) the use of the hook is restricted to the application for which it is approved, and (2) in questionable cases, concurrence is obtained from the appropriate safety organization.

b. If a handle or latch support whose design requires heat-treating is welded to the hook, welding shall be done prior to final heat-treating.

### 13.1.3 Load Limits

Hooks shall not be loaded beyond rated capacity except during load tests of the equipment of which they are a part.

### 13.1.4 Hook Standards

a. Hook design shall meet generally accepted hook design standards and be compatible with the requirements of ASME B30.10.

b. The hook material shall have sufficient ductility to permanently deform before failure at the ambient temperatures at which the hook will be used.

c. When a latch is provided, it shall be designed to retain such items as slings under slack conditions. The latch is not intended to support the load.

d. The bearing surfaces of new hooks shall be the arc of a circle. Gauge points, or hook gauges, for measuring spread after load testing should be provided.

e. Field-fabricated hooks shall meet the requirements of this section and shall be approved by the cognizant engineering and safety organizations.

## 13.2 INSPECTIONS

### 13.2.1 Hook Service

Hook service is defined as follows:

- a. Normal service—operation at less than 85 percent of rated capacity except for isolated instances.
- b. Heavy service—operation at 85 to 100 percent of rated capacity as a regular specified procedure.
- c. Severe service—operation at heavy service coupled with abnormal operating conditions, (i.e., extreme temperatures, corrosive atmospheres, etc.)

### 13.2.2 Initial Inspection

- a. Prior to initial use, all new and repaired hooks shall be inspected by a qualified inspector to ensure their compliance with the applicable provisions of ASME B30.10 Section 10-1.2. Dated and signed inspection records shall be kept on file and shall be readily available.
- b. Inspection procedure and recordkeeping requirements for hooks in regular service shall be governed by requirements for the kind of equipment in which they are used. When such requirements are stated in standards for the specific equipment, they shall take precedence over the requirements of this section.

### 13.2.3 Daily Inspection

- a. Operators or other designated personnel shall visually inspect hooks for deficiencies such as the following each day or prior to use if the hook has not been in regular service (records are not required):
  1. Cracks, nicks, and gouges.
  2. Deformation.
  3. Damage from chemicals.
  4. Latch engagement, damage to or malfunction of latch (if provided).
  5. Evidence of heat damage.
- b. A designated person shall examine

deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

### 13.2.4 Frequent Inspection

- a. Operators or other designated personnel shall visually inspect the hook at the following intervals (records are not required) :
  1. Normal service—monthly.
  2. Heavy service—weekly to monthly.
  3. Severe service—daily to weekly.
- b. These inspections shall, in addition to the requirements of Section 13.2.3, “Daily Inspection,” include the following:
  1. Wear.
  2. Hook attachment and securing means.
- c. A designated person shall examine deficiencies and determine whether they constitute a safety hazard and whether a more detailed inspection is required.

### 13.2.5 Periodic Inspection

- a. A qualified inspector shall perform a complete inspection at the following intervals:
  1. Normal service—yearly.
  2. Heavy service—semiannually.
  3. Severe service—quarterly.
- b. A designated person shall examine deficiencies and determine whether they constitute a safety hazard.
- c. The inspection shall include the requirements of Section 13.2.4, “Frequent Inspection.”
- d. Hooks shall receive a nondestructive test (NDT) according to Section 13.4, “Nondestructive Testing.”
- e. Hooks having any of the following conditions shall be removed from service until

repaired or replaced:

1. *Deformation*—Any bending or twisting exceeding 10E (or as recommended by the manufacturer) from the plane of the unbent hook.

2. *Throat opening*—Any distortion causing an increase in throat opening exceeding 15 percent (or as recommended by the manufacturer).

3. *Wear*—Any wear exceeding 10 percent (or as recommended by the manufacturer) of the original section dimension of the hook or its load pin.

4. Cracks.

5. If a latch is provided and it becomes inoperative because of wear or deformation or fails to fully bridge the throat opening, the hook shall be removed from service until the device has been repaired or replaced and the throat opening has been assessed as described above.

f. If hooks are painted, a visual inspection should take the coating into consideration. Surface variations can disclose evidence of heavy or severe service. The surface condition may call for stripping the paint in such instances.

g. Dated and signed inspection records shall be kept on file and shall be readily available.

h. A sample load test and inspection form is included as Exhibit I in Chapter 12, "Rigging Accessories." This form is intended to be a sample only and is not intended to be mandatory.

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## 13.3 TESTING

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- a. Each hook of 150-ton capacity or greater and a prototype of each hook design of less than 150-ton capacity shall be proof-tested by the manufacturer in accordance with Table 13-1.
- b. When proof tests are used, the hooks shall withstand the proof load application without permanent deformation when the load is applied for a minimum of 15 sec. This condition is considered satisfied if the permanent increase in the throat opening does not exceed 0.5 percent or 0.01 in. (0.25 mm), whichever is greater.
- c. For a duplex (sister) hook having a pin eye, the proof load for the eye shall be in accordance with Table 13-1. The proof load shall be shared equally between the two prongs of a sister hook, unless the hook is designed for unbalanced loading.
- d. Hooks that have been proof-tested shall be inspected by the magnetic-particle method in accordance with ASTM E-709 (“Standard Practice for Magnetic Particle Examination”) and shall show no cracks, inclusions, or other relevant discrepancies; castings shall be evaluated in accordance with ASTM E-165 (“Standard Practice for Liquid Penetrant Inspection Method.”)
- e. No performance testing of hooks shall be required, except as is necessary to conform to the requirements for the equipment of which they are a part.

**Table 13-1. Proof test load.**

Rated load,		% rated load	Proof load (minimum),	
tons (2,000 lb)	kg		tons (2,000 lb)	kg
0.50	453.6	200	1	907.2
1	907.2	200	2	1,814.4
5	4,536	200	10	9,072
10	9,072	200	20	18,144
15	13,608	200	30	27,216
20	18,144	200	40	36,288
25	22,680	200	50	45,360
30	27,216	200	60	54,432
35	31,752	200	70	63,504
40	36,288	200	80	72,576
45	40,824	200	0	81,648
50	45,360	200	100	90,720
60	54,432	193	116	105,235
75	68,040	183	137	124,286
100	90,720	166	166	150,595
125	113,400	150	188	170,554
150	136,080	133	200	181,440
175	158,760	133	233	211,378
200	181,440	133	266	241,315
250	226,800	133	333	302,098
300	272,160	133	399	361,973
350	317,520	133	465	421,848
400	362,880	133	532	482,630
450	408,240	133	598	542,506
500	453,600	133	665	603,288
Above 500	453,600	133		

Note: 1 ton (short, 2,000 lb) = 907.2 kg

For hooks with load ratings not shown above, use the next lower load rating for determining the percent of rated load to be applied.

## 13.4 NONDESTRUCTIVE TESTING (NDT)

### 13.4.1 NDT Requirements

a. For crane and hoist hooks of 10-ton rated capacity or greater that are assigned to heavy or severe service, a qualified inspector shall perform an NDT at the following intervals:

1. Heavy service: annually.
2. Severe service: semiannually.

b. A designated person or a qualified inspector shall perform an NDT for other hooks when deemed necessary for site-specific reasons.

c. If visual examination reveals a surface intersecting discontinuity (i.e., stress or fatigue cracks), a twist, increased throat opening, or any other defect, an NDT shall be performed to evaluate the hook further, regardless of its rated capacity or service classification.

### 13.4.2 NDT Records

Dated and signed NDT records, traceable to the hook by a serial number or other identifier, shall be kept on file as long as the hook remains in service and shall be readily available to appointed personnel.

### 13.4.3 NDT Methods

a. Use magnetic-particle testing or liquid-penetrant testing methods to inspect for surface intersecting discontinuities.

b. A qualified inspector or designated person shall perform NDTs in accordance with the following ASTM standards:

1. ASTM E-709.
2. ASTM E-165.

c. For magnetic-particle testing, a coil, yoke, or wet technique should be used to eliminate the possibility of prod burns or arc strikes.

d. Perform an NDT with the hook in place unless conditions indicate that disassembly for thread or shank inspection is necessary.

### 13.4.4 Acceptance Criteria

A designated person shall document and resolve the following relevant indications:

- a. Arc strikes (welding or electrical).
- b. Surface intersecting discontinuities 0.25 in. long or longer.

### 13.4.5 Discontinuity Removal

a. Two directions of discontinuity, "P" and "T," are shown on Figures 13-1 and 13-2. Discontinuity "P" parallels the contour of the hook, is considered nonserious, and does not require removal. Discontinuity "T," on the other hand, is transverse to the contour of the hook and is more serious; when occurring in zones B, C, or D, discontinuity "T" may reduce the longevity of the hook.

b. Discontinuities may be removed by grinding longitudinally following the contour of the hook to produce a smooth, gently undulating surface. In zones B and D, such grinding shall not reduce the original hook dimension by more than 10 percent. Such a reduction will not affect the working load limit rating or the ultimate load rating of the hook. In zone C, grinding shall not reduce the original dimension by more than 5 percent.

c. Under normal and proper application, zone A is an unstressed zone. Therefore, it is not required that discontinuities in that zone be ground out.

d. The hook shall be reexamined by performing an NDT after grinding to verify removal of relevant discontinuities.

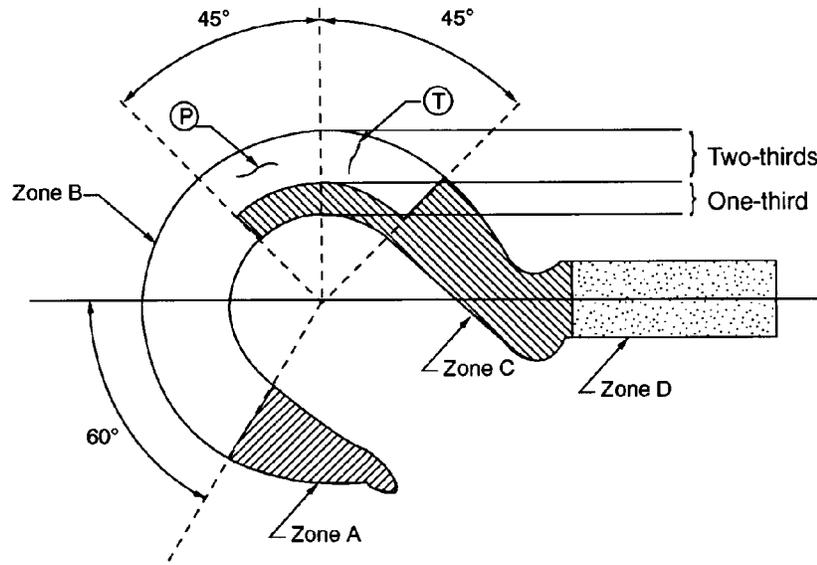


Figure 13-1. Shank hook.

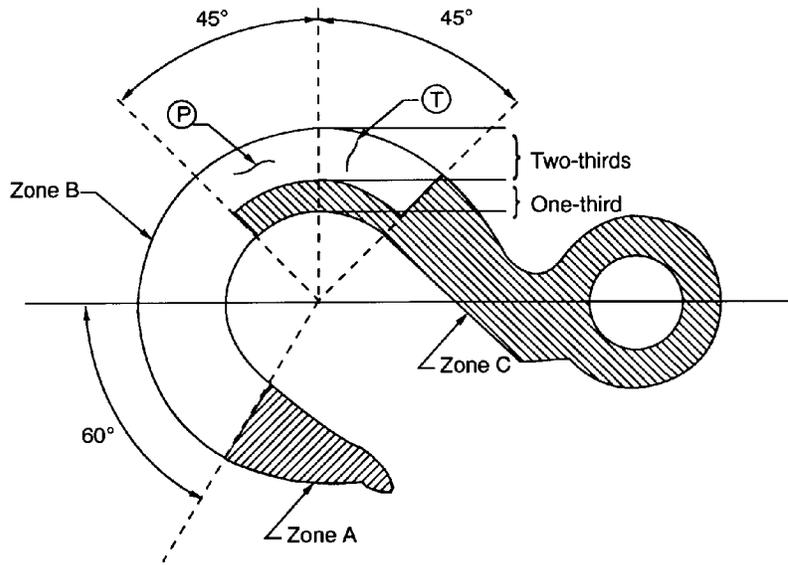


Figure 13-2. Eye hook.

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## 13.5 MAINTENANCE

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- a. A hook latch that is inoperative or missing shall be replaced.
- b. A hook with a latch that does not bridge the throat opening shall be removed from service until the latch is replaced or repaired and the hook is examined for deformation with special attention to the throat opening.
- c. A designated person shall repair cracks, nicks, and gouges by grinding longitudinally, following the contour of the hook, provided no dimension is reduced more than 10 percent (or as recommended by the manufacturer) of its original value.
- d. All other repairs shall be performed by the manufacturer or a qualified person.

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## 13.6 OPERATION

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Hook users shall do the following:

- a. Determine that the weight of the load to be lifted does not exceed the load rating of the hook.
- b. Avoid shock loading.
- c. Center the load in the base (bowl or saddle) of the hook to prevent point loading of the hook.
- d. Do not use hooks in such a manner as to place a side- or backload on the hook.
- e. When using a device to bridge the throat opening of the hook, ensure that no portion of the load is carried by the bridging device.
- f. Keep hands and fingers from between the hook and the load.
- g. Load duplex (sister) hooks equally on both sides, unless the hook is specifically designed for single loading.
- h. Do not load the pinhole in duplex (sister) hooks beyond the rated load of the hook.

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# CHAPTER 14

## BELOW-THE-HOOK LIFTING DEVICES

This chapter provides the requirements for below-the-hook lifting devices used in hoisting and rigging, such as spreader bars, lifting yokes, and lift fixtures. This section implements the requirements of ASME B30.20, “Below-the-Hook Lifting Devices.”

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## 14.1 GENERAL

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- a. Special lifting devices for shipping containers weighing 10,000 lb or more that are used for radioactive materials are governed by ANSI N14.6 [“Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4,500 kg) or More for Nuclear Materials.”]
  2. Vacuum lifting devices.
  3. Close-proximity-operated magnets.
  4. Remote-operated magnets.
- b. Below-the-hook lifting devices are arranged in the following groups because of the diversity of types:
  1. Structural and mechanical lifting devices.
  - c. Slings and rigging accessories that may be components in a below-the-hook lifting device are covered in Chapters 11 and 12 (“Wire Rope and Slings” and “Rigging Accessories,” respectively) of this manual.

## 14.2 STRUCTURAL AND MECHANICAL LIFTING DEVICES

a. Structural and mechanical lifting devices are often one-of-a-kind designs. Typical devices include:

1. Load-supporting lifting devices (Figure 14-1).
2. Friction-type pressure gripping lifting devices (Figure 14-2).
3. Indentation-type gripping lifting devices (Figure 14-3).
4. Cask lift fixtures (Figure 14-4).

### 14.2.1 Design/Fabrication

Structural and mechanical lifting devices shall be designed and fabricated according to the provisions of ASME B30.20, 20-1.2.2.

### 14.2.2 Marking

a. The rated capacity of each lifting device shall be marked on the main structure where it is visible and legible. If the lifting device comprises several items, each detachable from the assembly, each lifting device shall be marked with its rated capacity. At a minimum, a nameplate, name tag, or other permanent marker shall be affixed displaying the following data:

1. Manufacturer's name (contractor's name if fabricated onsite).
2. Lifting device weight (if over 100 lb).
3. Serial number (if applicable).
4. Rated capacity.

b. A rerated lifting device shall be relabeled with the new rated capacity.

c. Cases may exist where a lifting device cannot be marked with its rated capacity and weight. This may be due to the security classification of the load to be lifted or other reasons approved by the responsible manager. In these cases, the lifting device shall be marked with an identification number, and its documentation shall describe both its rated capacity and weight.

### 14.2.3 Modification/Rerating

a. Structural and mechanical lifting devices may be modified or rerated if the changes are analyzed by a qualified engineer or the manufacturer of the lifting device.

b. Rerated or modified lift fixtures shall be load-tested as described in Section 14.2.6.2, "Rated Load Test," below.

### 14.2.4 Guarding

Exposed moving parts or pinch points, such as gearing, chain drives, and rotating shafts, that may be a hazard to personnel during lifting operations shall be guarded.

### 14.2.5 Inspections

#### 14.2.5.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or repaired lifting devices to ensure compliance with Section 14.2.5.3, "Periodic Inspection."

#### 14.2.5.2 Frequent Inspection

a. The operator or other designated person shall visually inspect each lifting device at the beginning of each shift or prior to use, if it has not been in regular service, for the following items or conditions (records are not required):

1. Structural deformation, cracks, or excessive wear on any part.
2. Loose or missing guards, fasteners, covers, stops, or nameplates.
3. All operating mechanisms and automatic hold-and-release mechanisms for misadjustments interfering with operation.

4. The operator or designated person shall carefully examine any deficiencies and determine whether they constitute a hazard. Deficiencies noted during the inspection shall be corrected before the lifting device is used.

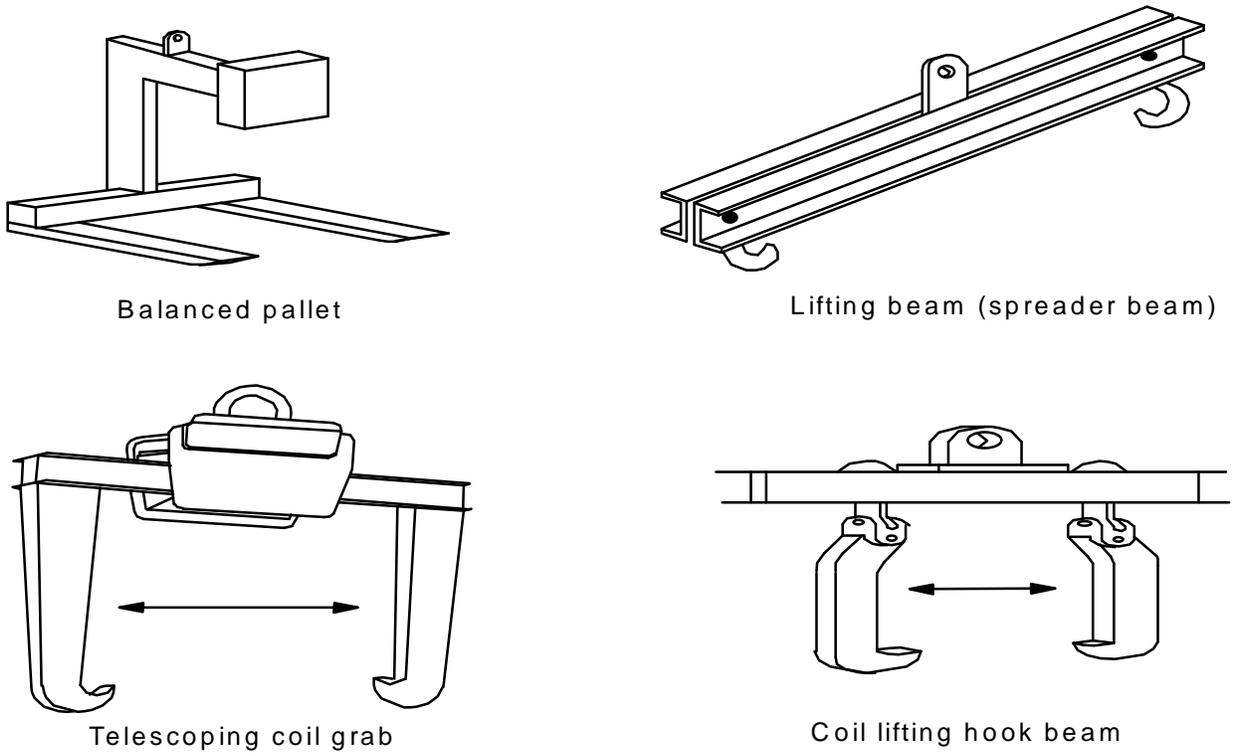


Figure 14-1. Load-supporting lifting devices.

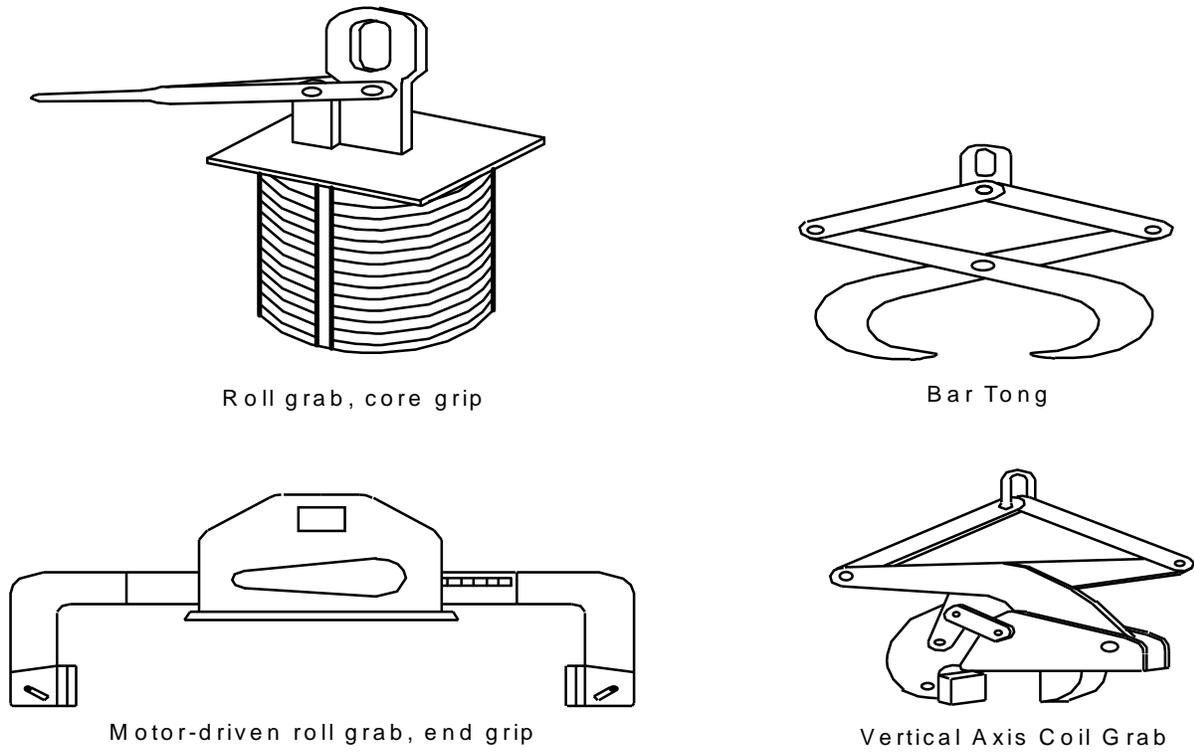
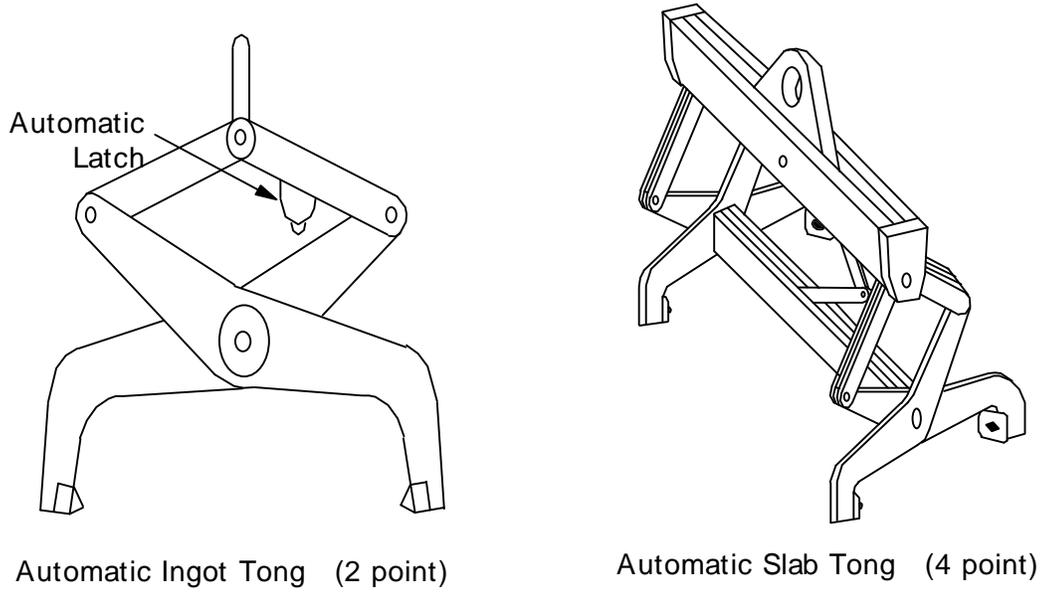
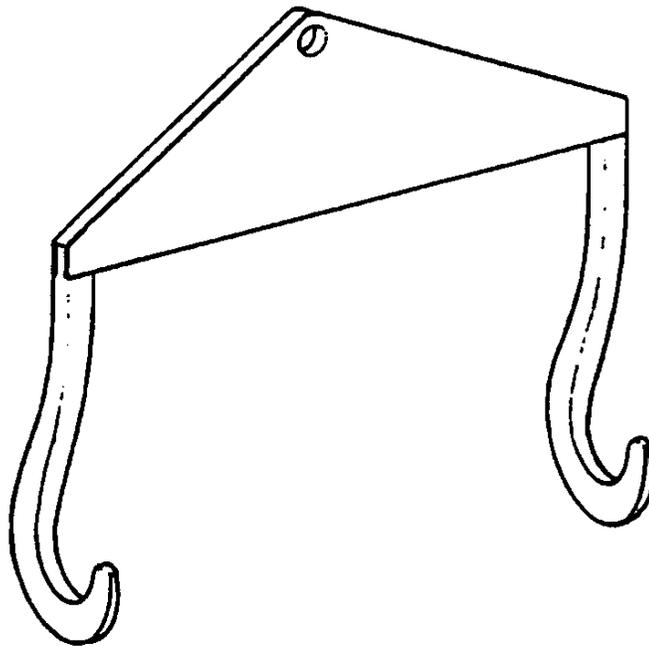


Figure 14-2. Friction-type pressure gripping lifting devices.



**Figure 14-3. Indentation-type gripping lifting device**



**Figure 14-4. Typical cask lift fixture.**

### 14.2.5.3 Periodic Inspection

a. A qualified inspector shall perform a complete inspection at the following intervals:

1. Normal service—yearly. Inspect equipment at site of use.
2. Heavy service—semiannually. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
3. Severe service—quarterly. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
4. Special or infrequent service—as recommended by a qualified person before the first such use and as directed by the qualified person for any subsequent uses.

b. Lifting device service is defined as follows:

1. Normal—operation with various weights within the rated load limit, or uniform loads less than 65 percent of rated load.
2. Heavy—operation within the rated load limit that exceeds normal service.
3. Severe—operation at normal or heavy service under abnormal operating conditions.

c. This inspection shall include the items listed in Section 14.2.5.2, “Frequent Inspection,” in addition to the following:

1. Loose bolts or fasteners.
2. Cracked or worn gears, pulleys, sheaves, sprockets, bearings, chains, and belts.
3. Excessive wear of friction pads, linkages, and other mechanical parts.
4. Excessive wear at hoist-attaching points and load-support shackles or pins.
5. External evidence of damage to motors or controls.

d. A qualified inspector shall inspect fixtures not in regular use according to periodic inspection requirements before placing them in service.

e. Dated reports of each periodic inspection shall be prepared. They shall be kept on file and shall be readily available. A sample load test and inspection form is included as Exhibit I at the end of this section. This form is intended to be a sample only and is not intended to be mandatory.

## 14.2.6 Testing

### 14.2.6.1 Operational Test

NOTE: Special lifting devices for shipping containers weighing 10,000 lb or more that are used for radioactive materials must be tested in accordance with ANSI N14.6.

a. Modified or repaired lifting devices shall be tested before initial use to ensure compliance with the requirements of this section (test reports kept on file). Testing shall include the following:

1. Lifting devices with moving parts shall be tested to confirm that the lifting device operates in accordance with manufacturer's instructions.

2. Lifting devices with manually operated or automatic latches shall be tested to verify that the latches operate in accordance with manufacturer's instructions.

### 14.2.6.2 Rated Load Test

a. All new, altered, modified, or repaired lifting devices shall be tested and inspected before use. The results of the test and inspection shall be documented in the equipment history file.

b. The rated capacity shall not be more than 80 percent of the maximum load sustained during the test. Test loads shall not be more than 125 percent of the rated capacity unless otherwise recommended by the manufacturer.

c. The rated load test shall consist of the following:

1. Hoist the test load a sufficient distance to ensure that it is supported by the lifting device, or apply the required load if the test is made using a testing machine. Personnel shall remain clear of suspended loads.

2. Visually inspect the lifting device for deformation, cracks, or other defects after the load test is completed.

## 14.2.7 Maintenance

- a. A preventive maintenance program should be established and be based on recommendations made by the lifting device manufacturer or a qualified person.
- b. Replacement parts shall be equivalent to the original specifications.

## 14.2.8 Training/Qualification

- a. Below-the-hook lifting device operators shall be trained and qualified as required in Chapter 6, "Personnel Qualification and Training." At a minimum, instruction should include the following:
  1. Application of the lifting device to the load and adjustments to the device, if any, that adapt it to various sizes or kinds of loads.
  2. Any special operations or precautions.
  3. Condition of the load itself required for operation of the lifting device such as balance, degree of order of stacked loads, surface cleanliness, bending, and load thickness.
  4. Procedure for storage of lifting device to protect it from damage.
  5. Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.
- b. Operators shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

## 14.2.9 Operation

- a. Only the following personnel shall operate structural and mechanical lifting devices:
  1. Qualified operators or riggers.
  2. Trainees under the direct supervision of a qualified operator.
  3. Maintenance and test personnel, when it is necessary in the performance of their duties.

4. Inspectors of lifting devices.

- b. The following shall apply to all personnel who operate structural and mechanical lifting devices:
  1. Observe the condition of the lifting device before use and during operation. If you observe a defect that affects the continued safe use of the lifting device, remove it from service.
  2. Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving.
  3. Before they are used on each shift, test the lifting device controls. If any controls do not operate properly, adjust or repair them before operations begin.
  4. Do not load the lifting device in excess of its rated capacity (except for test loads) or handle any load for which it is not designed.
  5. Apply the lifting device to the load in accordance with established procedures.
  6. Before lifting, ensure that lifting-device ropes or chains are not kinked and multiple-part lines are not interwoven.
  7. Ensure that the load is correctly distributed for the lifting device being used.
  8. Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person or by an approved procedure.
  9. Do not use a lifting device that is tagged "Danger—Do Not Operate" or otherwise designated as nonfunctional.
  10. Do not remove "Danger—Do Not Operate" tags from lifting devices without the approval of the person who placed them or an authorized person.
  11. Store the lifting device in a dry, inside location when not in use.
  12. Ensure that markings or tags are not removed or defaced. Replace missing or defaced markings or tags.

## 14.3 VACUUM LIFTING DEVICES

Typical power-operated and mechanically operated vacuum lifting and manipulating devices are shown in Figures 14-5 and 14-6. This section does not cover devices used to handle porous materials, which requires special design and construction.

### 14.3.1 Design/Fabrication

Power- and mechanically operated vacuum lifting devices shall be designed and fabricated according to the provisions of ASME B30.20, 20-2.2.2.

### 14.3.2 Marking

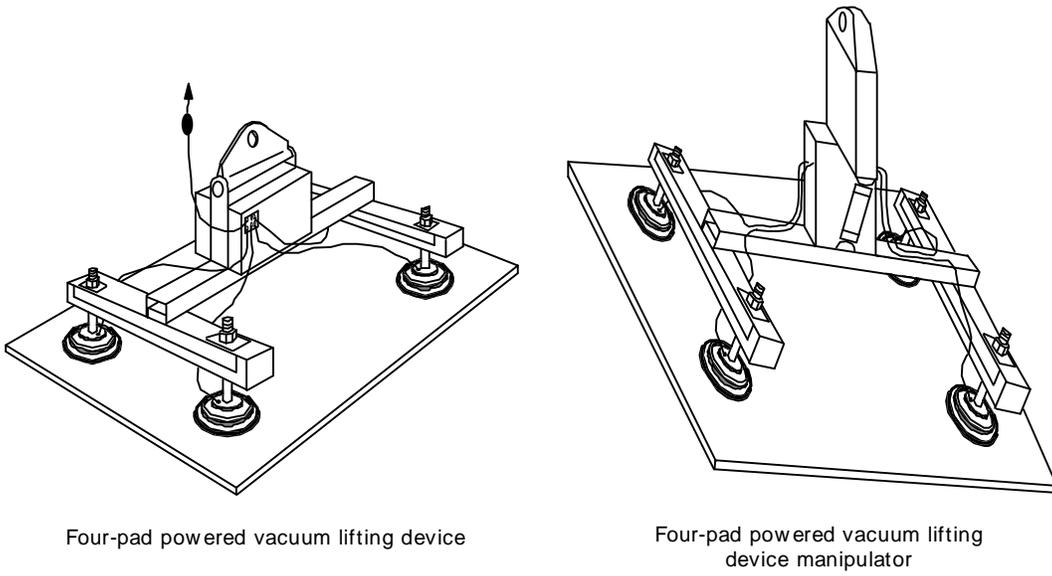
- a. The rated capacity, maximum width and length, and minimum thickness of load shall be marked on the main structure where it is visible and legible.
- b. Individual pads or groups of pads, controlled by shutoff valves, shall be marked with the rated capacity of each pad or group of pads.
- c. At a minimum, a nameplate, name tag, or other permanent marker shall be affixed to each lifter displaying the following data:
  1. Manufacturer's name.
  2. Model number or unit identification.
  3. Weight of lifting-device.
  4. Electric power (when applicable).
  5. Pressure and volume of compressed air (when applicable).
  6. Rated capacity.
- d. Manual shutoff valves on individual pads or groups of pads shall be marked to show operating position.
- e. Cases may exist where a lifting device cannot be marked with its rated capacity and weight. This may be due to the security classification of the load to be lifted or other reasons approved by the responsible manager. In

these cases, the lifting device shall be marked with an identification number, and its documentation shall contain both its rated capacity and weight.

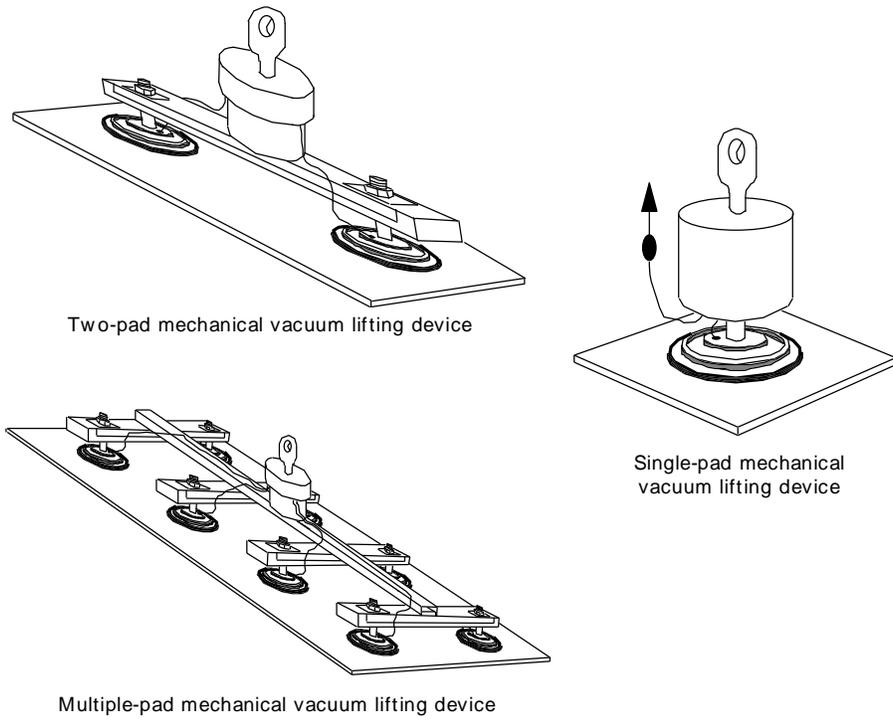
f. A label or labels shall be affixed to each vacuum lifting device in a readable position that displays the word "WARNING" or other legend designed to bring the label to the attention of the operator. The label shall also contain information cautioning against:

1. Exceeding the rated capacity or lifting loads not specified in the manufacturer's instruction manual.
2. Operating a damaged or malfunctioning unit or a unit with missing parts.
3. Operating when vacuum indicators show insufficient vacuum.
4. Operating the unit when vacuum pads are not spaced for equal loading.
5. Incorrect positioning of the lifting device on the load.
6. Lifting people.
7. Moving loads above people.
8. Removing/obscuring warning labels.
9. Operating the lifting device when the rated capacity, lifting-device weight, or safety markings are missing (except in cases where the device cannot, for security or other reasons, be marked).
10. Making alterations or modifications to the lifting device.
11. Lifting loads higher than necessary and leaving suspended loads unattended.

g. A label shall be affixed to each unit that directs the user to consult the manufacturer's manual if the size or shape of the unit prohibits the inclusion of the above markings.



**Figure 14-5. Powered vacuum lifting devices.**



**Figure 14-6. Mechanical vacuum lifting devices.**

### 14.3.3 Installation

- a. Vacuum lifting devices shall be assembled and installed in accordance with the manufacturer's instructions.
- b. The power supply to the vacuum lifting device shall be the same as that shown on the nameplate and shall be connected to the line side of the crane disconnect or to an independent circuit.
- c. The user shall check for correct rotation of all pumps.

### 14.3.4 Inspections

#### 14.3.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new or repaired vacuum lifting devices to ensure their compliance with Section 14.3.4.3, "Periodic Inspection."

#### 14.3.4.2 Frequent Inspection

- a. The operator or other designated person shall inspect each vacuum lifting device at the beginning of each shift or prior to use, if it has not been in regular service.
- b. The inspection shall be for the following (records are not required):
  1. Deformation, cracks, and excessive wear of load-bearing parts.
  2. Adequate vacuum generator output.
  3. Cuts, tears, excessive wear, and foreign particles at vacuum pad seal rings.
  4. Leakage, cuts, kinks, and collapsed areas of vacuum lines/connections.
  5. Leaks or damage to the vacuum reservoir.
  6. Failure of the entire vacuum system to function properly by attaching a nonporous, clean test plate to the vacuum pads and then stopping the vacuum source. Vacuum levels in the system shall not decrease by more than the manufacturer's specified rate.

#### 14.3.4.3 Periodic Inspection

- a. A qualified inspector shall perform a complete inspection at the following intervals:
  1. Normal service—yearly. Inspect equipment at site of use.
  2. Heavy service—semiannually. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
  3. Severe service—quarterly. Inspect equipment at site of use unless external conditions indicate that disassembly should be done to permit detailed inspection.
  4. Special or infrequent service—as recommended by a qualified person before the first use and as directed by the qualified person for any subsequent occurrences.
- b. Lifting device service is defined as follows:
  1. Normal—operation with various weights within the rated load limit, or uniform loads less than 65 percent of rated load.
  2. Heavy—operation within the rated load limit that exceeds normal service.
  3. Severe—operation under normal or heavy service with abnormal operating conditions.
- c. This inspection shall include those conditions or items specified in Section 14.3.4.2, "Frequent Inspection," in addition to the following:
  1. External evidence of looseness, wear, deformation, cracking, or corrosion.
  2. External evidence of damage to supporting structure, motors, controls, and other auxiliary components.
  3. Presence of warning label required by Section 14.3.2, "Marking."
- d. A qualified inspector shall inspect fixtures not in regular use according to periodic inspection requirements before placing them in service.
- e. Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

## 14.3.5 Testing

### 14.3.5.1 Operational Test

a. All new, reinstalled, modified, or repaired vacuum lifting fixtures shall be tested prior to use. Tests shall be performed by a qualified inspector or under the direction of that inspector to ensure compliance with the requirements of this section. Dated reports shall be kept on file.

b. Testing shall include the following:

1. Seals and connections shall be tested for leaks by attaching a nonporous, clean test plate to the vacuum pads and then stopping the vacuum source. Vacuum level in the system shall not decrease by more than the rate specified by the manufacturer.

2. Test indicator lights, gauges, horns, bells, pointers, or other warning devices and vacuum level indicators for proper operation.

### 14.3.5.2 Rated Load Test

a. All new, reinstalled, repaired, or modified vacuum lifting devices shall be tested and inspected before use. Tests and inspections shall be performed by a qualified inspector or under the direction of that inspector. Test and inspection results shall be documented and kept on file.

b. The rated capacity shall not be more than 80 percent of the maximum load sustained during the test. Test loads shall not be more than 125 percent of the rated capacity unless otherwise recommended by the manufacturer.

c. The rated load test shall consist of the following steps at a minimum:

1. Attach pads to the designated test load.
2. Raise the test load a minimum distance to ensure that it is supported by the vacuum lifting device, and hold it for 2 min.
3. Remain clear of the suspended load.
4. Lower and release the load.
5. Visually inspect the vacuum lifting device for defects and correct any deficiencies prior to returning the device to service.

## 14.3.6 Maintenance

a. A preventive maintenance program should be established and be based on recommendations made by the vacuum lifting device manufacturer or a qualified person.

b. Replacement parts shall be equivalent to the original specifications.

c. The vacuum generator, vacuum pads, sealing rings, mufflers, and filters should be maintained and cleaned according to the manufacturer's specifications.

## 14.3.7 Training/Qualification

a. Vacuum lifting device operators shall be trained and qualified as specified in Chapter 6, "Personnel Qualification and Training." At a minimum, instruction should include the following (as applicable):

1. Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.
2. Any special operations or precautions.
3. Condition of the load itself required for operation of the lifting device such as balance, degree of order of stacked loads, surface cleanliness, bending, and load thickness.
4. Procedure for storage of lifting device to protect it from damage.
5. Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.
6. Charging of the battery (if required).
7. The purpose of indicators, meters, or alarms on the vacuum lifting device.
8. The proper attachment of adaptors to vacuum lifting devices for handling of special loads.

b. Users shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

### 14.3.8 Operation

a. Only the following personnel shall operate vacuum lifting devices:

1. Qualified operators or riggers.
2. Trainees under the direct supervision of a qualified operator.
3. Maintenance and test personnel, when it is necessary in the performance of their duties.
4. Inspectors of lifting devices.

b. The following shall apply to all personnel who operate vacuum lifting devices:

1. Before starting the lift, verify that the “vacuum on” indicator has reached the required level. Also, verify that the vacuum lifting device has been correctly applied and a stable vacuum level exists by lifting the load a few inches and observing conditions.
2. Observe the condition of the lifting device before use and during operation. If you observe a defect that affects the continued safe use of the lifting device, remove it from service.
3. Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving.
4. Before they are used on a shift, test the lifting device controls. If any do not operate properly, adjust or repair them before operations begin.
5. Do not load the lifting device in excess of its rated capacity (except for test loads) or

handle any load for which it is not designed.

6. Apply the lifting device to the load in accordance with established procedures.

7. Before lifting, ensure that lifting-device ropes or chains are not kinked and multiple-part lines are not interwoven.

8. Ensure that the load is correctly distributed for the lifting device being used.

9. Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person or by an approved procedure.

10. Warn all personnel in the vicinity of the lifting device and place the load on the floor or ground, if possible to do so, if electrical power goes off while a load is being lifted.

11. Do not leave your position at the controls.

12. Do not use a lifting device that is tagged “Danger—Do Not Operate” or otherwise designated as nonfunctional.

13. Do not remove “Danger—Do Not Operate” tags from lifting devices without the approval of the person who placed them or an authorized person.

14. Store the lifting device in a dry, inside location when not in use.

15. Ensure that markings or tags are not removed or defaced. Replace missing or defaced markings or tags.

## 14.4 MAGNETS, CLOSE-PROXIMITY-OPERATED

Close-proximity-operated magnetic lifting devices are used for single- or multiple-steel-piece handling operations in which the operator of the magnet is required to manually guide the load during its movement. They are also used in situations where remotely operated magnets are operated close to people. Typical close-proximity-operated magnetic lifting devices are shown in Figure 14-7.

### 14.4.1 Design/Fabrication

Close-proximity-operated magnetic lifting devices shall be designed and fabricated in accordance with the provisions of ASME B30.20, 20-3.2.2 and 20-3.2.3.

### 14.4.2 Marking

a. At a minimum, a nameplate, name tag, or other permanent marker shall be affixed to each lifting magnet, and shall display the following data:

1. Manufacturer's name, or if the magnet has been repaired or modified, the name and address of the repairer/modifier.
2. Model or unit identification.
3. Weight.
4. Duty cycle, if applicable.
5. Cold current.
6. Rated capacity.

b. Also, battery-powered and external-powered lifting electromagnets and electrically controlled permanent-magnet lifting magnets shall be marked with:

1. The voltage of the battery or primary power supply.
2. The cold current or watts at 68 degrees F (20 degrees C) and rated voltage.

c. Cases may exist where a lifting device cannot be marked with its rated capacity and weight. This may be due to the security classification of the load to be lifted or other reasons approved by the responsible manager. In these cases, the lifting device shall be marked with an identification number, and its documentation

shall contain both its rated capacity and weight.

d. A label or labels shall be affixed to each lifting magnet in a readable position that displays the word "CAUTION" or other legend designed to bring the label to the attention of the operator. The label shall also contain information cautioning against:

1. Operating when the battery capacity is inadequate.
2. Exceeding magnet duty cycle and disconnecting the magnet with the power on (for externally powered electromagnets).
3. Operating if the internal control function indicator, where applicable, does not indicate a complete cycle (on electrically controlled permanent magnets).
4. Operating with the control handle not fully in the "Lift" position (on manually controlled permanent magnets).

#### 14.4.2.1 Rated Load (Capacity)

a. General-application magnets shall include the rated load (capacity) of the magnet on the lifting magnet or on a tag attached to it. This capacity rating shall refer to the instruction manual for information relating to decreases in rating due to the load surface condition, thickness, percentage of contact with magnet, temperature, metallurgical composition, and deflection.

b. Specified-application magnets shall include the application load (capacity) of the magnet on the lifting magnet or on a tag attached to it. This capacity rating shall refer to the specific loads for which it applies.

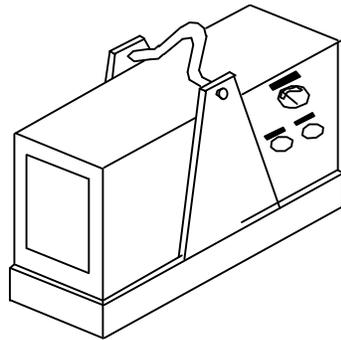
#### 14.4.2.2 Controls

The position of the control switch or handle of a lifting magnet shall be marked with "Lift," "Off," and "Drop," or equivalent terms indicating the mode of operation of the lifting magnet.

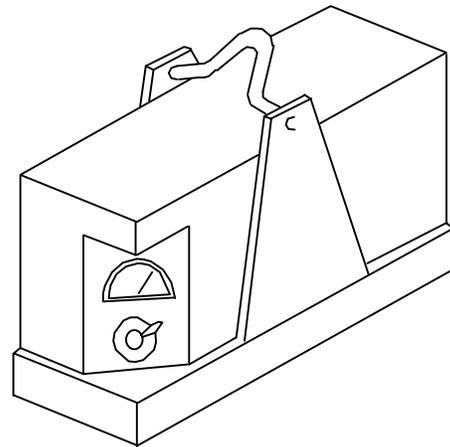
### 14.4.3 Installation

a. Close-proximity-operated magnetic lifting devices shall be installed according to the manufacturer's recommendations.

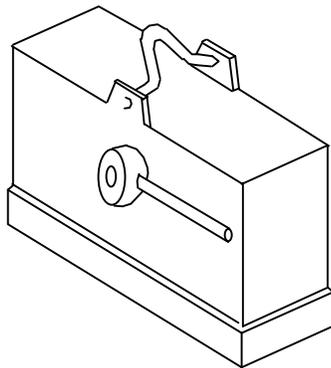
b. Users shall ensure that:



Close-proximity-operated lifting electromagnet



Close-proximity-operated electrically controlled permanent magnet



Close-proximity-operated manually controlled permanent magnet

**Figure 14-7. Close-proximity-operated magnetic lifting devices.**

1. External power input is the correct voltage and amperage.
2. Power conductors and controls are of adequate rating and are insulated or otherwise protected against accidental interruption or damage.

## 14.4.4 Inspections

### 14.4.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or repaired lifting magnets to ensure compliance with Section 14.4.4.3, "Periodic Inspection."

#### 14.4.4.2 Frequent Inspection

a. The operator or other designated person shall visually inspect each magnetic lifting device at the beginning of each shift or prior to use, if it has not been in regular service.

b. The inspection shall be for the following (records are not required):

1. Lifting magnet face for freedom from foreign materials and for smoothness.
2. Lifting bail or sling suspension for proper condition.
3. Control handle for proper condition and operation.
4. Current indicator, where applicable, for proper condition and operation.
5. Labels, markings, and indicators or meters for legibility.
6. Electrical conductors, if applicable, for loose connections, continuity, corrosion, and damage to insulation.
7. Battery for correct electrolyte level and lack of corrosion of battery posts or connectors, if applicable.

#### 14.4.4.3 Periodic Inspection

a. A qualified inspector shall perform a complete inspection with the equipment in place at the following intervals:

1. Normal service—yearly.
2. Heavy service—yearly.

3. Severe service—quarterly.

b. Lifting device service is defined as:

1. Normal—operation with various weights within the rated load limit, or uniform loads less than 65 percent of rated load.

2. Heavy—operation within the rated load limit that exceeds normal service.

3. Severe—operation under normal or heavy service with abnormal operating conditions.

c. This inspection shall include those items specified in Section 14.4.4.2, "Frequent Inspection," in addition to the following:

1. Deformation, wear, and corrosion of all members, fasteners, locks, switches, warning labels, and lifting parts.

2. Operation and condition of electrical components (i.e., meters, indicators, and alarms).

3. Magnet coil tested for ohmic/ground readings and readings compared to manufacturer's standards.

d. A qualified inspector shall inspect a lifting magnet that has been idle for 1 month or more according to periodic inspection requirements before placing it in service.

e. Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

## 14.4.5 Testing

### 14.4.5.1 Operational Test

a. All new, modified, or repaired lifting magnets shall be tested prior to their initial use. Tests shall be performed by a qualified inspector or under the direction of that inspector. Dated reports shall be kept on file.

b. Testing shall include the following:

1. A check to ensure that the lifting magnet contains no visible defects.

2. A check for proper operation of all electrical protective equipment, meters, indicators, alarms, etc.

#### 14.4.5.2 Rated Load Test

- a. All new, modified, or repaired lifting magnets shall be tested and inspected before initial use. Tests and inspections shall be performed by a qualified inspector or under the direction of that inspector. Test and inspection results shall be documented and kept on file.
- b. General-application magnets are required to satisfy the rated breakaway-force test. The breakaway force measured in this test must exceed the rated load (capacity) by a factor of at least 2.
- c. Specified-application magnets are required to comply with the application breakaway-force test. The breakaway forces measured in this test must exceed the specified application load (capacity) by a factor of at least 2.
- d. The rated breakaway-force test shall establish the breakaway force required to vertically remove the lifting magnet from a low-carbon rolled-steel plate of the minimum thickness stated by the magnet manufacturer. The portion of this plate in contact with the magnet shall have a 125- $\mu$ in. ( $3.2 \times 10^{-3}$  mm) finish and be flat within 0.002 in./ft (0.05 mm/m), but not exceeding 0.005 in. (0.127 mm) total. The full operating face of the lifting magnet shall be in contact with the steel plate, which shall be between 60 degrees F (15 degrees C) and 120 degrees F (50 degrees C). Battery-operated electromagnets and external-powered lifting electromagnets shall be operated at the manufacturer's recommended current.
- e. The application breakaway-force test shall establish the application breakaway forces of the lifting magnet under the variety of loading conditions for which the magnet is specified. The details of this test should be supplied by the manufacturer of the lifting magnet.

#### 14.4.6 Maintenance

- a. A preventive maintenance program should be established and be based on recommendations made by the manufacturer or a qualified person.
- b. Replacement parts shall be equivalent to the original specifications.
- c. Before adjustment and repairs are started on a lifting magnet or its controls, maintenance personnel shall take the following precautions:
  1. Ensure that all sources of magnet power are disconnected and locked out, tagged out, or flagged.

2. Ensure that a magnet removed for repair is tagged as defective.

- d. Only qualified personnel shall work on equipment when adjustments and tests are required.

- e. After adjustments and repairs have been made, the lifting magnet shall not be returned to service until it has been inspected according to Section 14.4.4.3.

- f. Dated records of repairs and replacements should be available.

- g. Maintenance personnel shall ensure that any defective condition disclosed by the inspection is corrected before operation of the lifting magnet is resumed. Repairs shall be done only by designated persons.

#### 14.4.7 Training/Qualification

- a. Magnetic lifting device operators shall be trained and qualified as specified in Chapter 6, "Personnel Qualification and Training." At a minimum, instruction should include the following:
  1. Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.
  2. Any special operations or precautions.
  3. Condition of the load itself required for operation of the lifting device such as balance, degree of order of stacked loads, surface cleanliness, bending, and load thickness.
  4. Procedure for storage of lifting device to protect it from damage.
  5. Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.
  6. Charging of the lifting magnet battery (if required).
  7. The purpose of indicators, meters, or alarms on the lifting magnet.
  8. The proper attachment of adaptors to lifting magnets for handling of special loads.

- b. Operators shall demonstrate the ability and competence to operate the lifting device as

instructed before assuming responsibility for using it.

### 14.4.8 Operation

a. Only the following qualified personnel shall operate lifting devices:

1. Designated persons.
2. Trainees under the direct supervision of a designated person.
3. Maintenance and test personnel, when it is necessary in the performance of their duties.
4. Inspectors of lifting devices.

b. The following shall apply to personnel who use close-proximity-operated magnets:

1. Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving it.
2. Before they are used during a shift, test all controls. If any do not operate properly, adjust or repair them before operations begin.
3. Do not load the lifting device in excess of its rated capacity or handle any load for which it is not designed.
4. Apply the lifting device to the load in accordance with established procedures.
5. Before lifting, ensure that lifting-device ropes or chains are not kinked and that multiple-part lines are not interwoven.
6. Ensure that the load is correctly distributed for the lifting device being used.
7. Ensure that the temperature of the load does not exceed the maximum allowable limits of the lifting device.
8. Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person.
9. Keep the lifting magnet face and the magnet contact area clean.
10. Ensure that the load to be lifted is within the magnet's rated capacity or application capacity and lifting equipment rated capacity.
11. Observe all meters and indicators on the lifting magnet to confirm proper operation

prior to making a lift.

12. Before starting the lift, lift the load a few inches to establish that it is securely attached to the magnet.

13. Do not use a lifting magnet that is tagged "Danger—Do Not Operate" or otherwise designated as nonfunctional.

14. Do not remove "Danger—Do Not Operate" tags from magnetic lifting devices without the approval of the person who placed them or an authorized person.

15. Store the lifting device in a dry, inside location when not in use.

#### 14.4.8.1 External-Powered Electromagnets

Before raising the load more than 2 in. (50 mm), ensure that any adjustable input control is switched to the "FULL POWER" or "FULL ON" position and remains in this position until the load is removed from the magnet.

#### 14.4.8.2 Battery-Operated Electromagnets

- a. Before lifting, confirm that the device indicating correct current flow remains stable for a minimum of 5 sec.
- b. For a lift of extended duration, observe the device indicating correct current flow every 5 min.
- c. Open the ventilation lid before charging the battery.
- d. Before raising the load more than 2 in. (50 mm), ensure that any adjustable input control is switched to the "FULL POWER" or "FULL ON" position and remains in this position until the load is removed.

#### 14.4.8.3 Electrically Controlled Permanent Magnets

Before raising the load, check the internal control function indicator, where applicable, to confirm proper operation of the lifting magnet.

#### 14.4.8.4 Manually Controlled Permanent Magnets

Before raising the load, confirm that the control handle is in the "LIFT" or "ON" position and the control handle latch is operating.

## 14.5 MAGNETS, REMOTE-OPERATED

Typical remote-operated magnetic lifting devices are shown in Figure 14-8.

### 14.5.1 Design/Fabrication

Remote-operated magnetic lifting devices shall be designed and fabricated in accordance with the provisions of ASME B30.20, 20-4.2.2.

### 14.5.2 Marking

a. At a minimum, all new lifting magnets shall be provided with a nameplate, name tag, or other permanent marker displaying the following information:

1. Manufacturer's name and address, or if the magnet has been repaired or modified, the name and address of the repairer/modifier.
2. Manufacturer's model or unit identification.
3. Weight.
4. Duty cycle, if applicable.
5. Cold current.

b. Cases may exist where a lifting device cannot be marked with its rated capacity and weight. This may be due to the security classification of the load to be lifted or other reasons approved by the responsible manager. In these cases, the lifting device shall be marked with an identification number, and its documentation shall contain both its rated capacity and weight.

### 14.5.3 Installation

- a. Remote-operated magnets shall be installed according to the manufacturer's recommendations.
- b. Operators shall ensure that:

1. External power input is of the correct voltage and amperage.
2. Power conductors and controls are of adequate rating and are insulated or otherwise protected against accidental interruption or damage.

### 14.5.4 Inspections

#### 14.5.4.1 Initial Inspection

Prior to their initial use, a qualified inspector shall inspect all new, modified, or repaired lifting magnets to ensure compliance with Section 14.5.4.3, "Periodic Inspection."

#### 14.5.4.2 Frequent Inspection

a. The operator or other designated personnel shall visually inspect each magnetic lifting device at the beginning of each shift or prior to use, if it has not been in regular service.

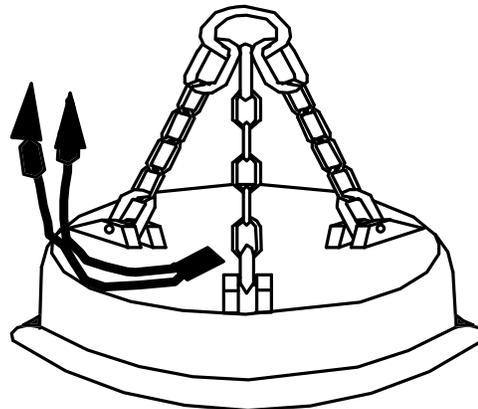
b. The inspection shall be for the following (records are not required):

1. Lifting magnet face for smoothness or presence of foreign materials, if applicable.
2. Magnet suspension system.
3. All visible electrical conductors (without disassembly).

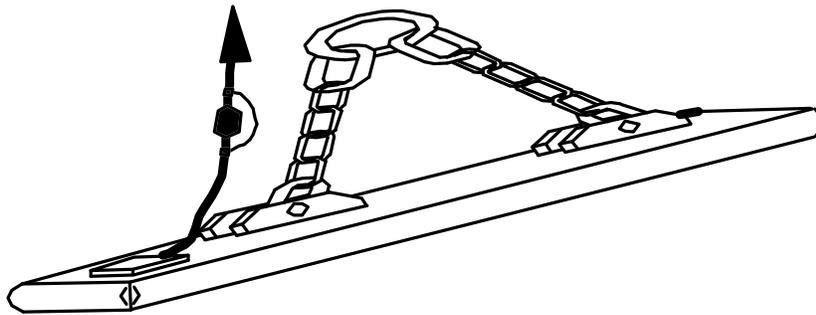
#### 14.5.4.3 Periodic Inspection

a. A qualified inspector shall perform a complete inspection of the lifting device with the equipment in place at the following intervals:

1. Normal service—yearly.
2. Heavy service—quarterly.
3. Severe service—quarterly.



Remote-operated lifting  
electromagnet -- circular



Remote-operated lifting  
Electromagnet -- rectangular

**Figure 14-8. Remote-operated magnetic lifting devices.**

4. Special or infrequent service—as authorized by a qualified person before the first use and as directed by the qualified person for any subsequent occurrences.

b. Lifting device service is defined as follows:

1. Normal—operation with various weights within the rated load limit, or uniform loads less than 65 percent of rated load.

2. Heavy—operation within the rated load limit that exceeds normal service.

3. Severe—operation under normal or heavy service with abnormal operating conditions.

c. This inspection shall include those items specified in Section 14.5.4.2, “Frequent Inspection,” in addition to the following:

1. Deformation, wear, and corrosion of all members, fasteners, and lifting parts.

2. Proper operation and condition of electrical components.

3. Magnetic coil tested for ohmic/ground readings and compared to manufacturer's standards.

d. Dated inspection reports shall be prepared for each inspection. Inspection records shall be kept on file and shall be readily available.

## 14.5.5 Testing

### 14.5.5.1 Operational Test

a. All new, modified, or repaired lifting magnets shall be tested prior to initial use. Tests shall be performed by a qualified inspector or under the direction of that inspector. Dated reports shall be kept on file.

b. Testing shall include the following:

1. A check for proper operation of all electrical equipment.

2. A visual inspection of the lifting magnet for visible defects.

## 14.5.6 Maintenance

a. A preventive maintenance program should be established and be based on the

recommendations of the manufacturer or a qualified person.

b. Replacement parts shall be equivalent to original specifications.

c. Before maintenance is started on a lifting magnet or controls, maintenance personnel shall take the following precautions:

1. Ensure that all sources of magnet power are disconnected and locked out, tagged out, or flagged.

2. Ensure that a magnet removed for repair is tagged as defective.

d. Only qualified personnel shall work on equipment when maintenance and tests are required.

e. After repairs have been made, the lifting magnet shall not be returned to service until it has been inspected according to Section 14.5.4.3.

f. Dated records of repairs and replacements should be available.

g. Any defective condition disclosed by the inspection shall be corrected before the lifting magnet is returned to service.

## 14.5.7 Training/Qualification

a. Operators shall be trained and qualified as specified in Chapter 6, “Personnel Qualification and Training.” At a minimum, instruction should include the following:

1. Application of the lifting device to the load and adjustments of the device, if any, that adapt it to various sizes or kinds of loads.

2. Any special operations or precautions.

3. Condition of the load itself required for operation of the lifting device, such as balance, degree of order of stacked loads, surface cleanliness, bending, and load thickness.

4. Procedure for storage of the lifting device to protect it from damage.

5. Instructions for not exceeding the rated capacity of the lifting device or the capacity of the hoisting equipment by the combined weight of the load, the lifting device, and the rigging.

6. Charging of the lifting magnet battery (if required).

7. The purpose of indicators, meters, or alarms on the lifting magnet.

8. The proper attachment of adaptors to lifting magnets for handling of special loads.

b. Operators shall demonstrate the ability and competence to operate the lifting device as instructed before assuming responsibility for using it.

### 14.5.8 Operation

a. Only the following qualified personnel shall operate lifting devices:

1. Designated persons.

2. Trainees under the direct supervision of a designated person.

3. Maintenance and test personnel, when it is necessary in the performance of their duties.

4. Inspectors of lifting devices.

b. The following shall apply to all personnel who operate remote-operated magnets:

1. Place any attached load on the floor or ground and, after use, properly store the lifting device before leaving it.

2. Before they are used during a shift, test all controls. If any do not operate properly, adjust or repair them before operations begin.

3. Do not load the lifting device in excess of its rated capacity or handle any load for which it is not designed.

4. Apply the lifting device to the load in accordance with established procedures.

5. Before lifting, ensure that lifting-device ropes or chains are not kinked and that multiple-part lines are not interwoven.

6. Ensure that the load is correctly distributed for the lifting device being used.

7. Ensure that the temperature of the load does not exceed the maximum allowable limits of the lifting device.

8. Do not use the lifting device for side pulls or sliding the load unless specifically authorized by a qualified person.

9. Do not use a lifting magnet that is tagged “Danger—Do Not Operate” or otherwise designated as nonfunctional.

10. Do not remove “Danger—Do Not Operate” tags without the approval of the person who placed them or an authorized person.

11. Store the lifting device in a designated location when not in use.

Exhibit I is intended to be a sample form only and is not mandatory. Any other form that accomplishes the purpose is acceptable.

EXHIBIT I

LIFTING BARS AND SPREADERS LOAD TEST AND INSPECTION

INSPECTOR \_\_\_\_\_ INSPECTION DATE \_\_\_\_\_

- NOTES:**
1. Proof-test to 200% of rated capacity for critical lift service. The test load shall be accurate to within -5%, +0% of stipulated values.
  2. Qualified inspector shall witness all steps below.

\_\_\_\_\_

INSPECTION

Lifting bars and spreaders shall be checked for signs of incipient failure in bending and shall be replaced if permanently bent more than 1/2 in. in 10 ft or twisted more than 5 degrees out of the original plan. Hook attachment welds shall be examined for cracks and signs of failure in tension.

Qualified inspector shall perform test by visual examination, liquid-penetrant examination, or magnetic-particle examination.

Acceptance: No cracks, linear indication, laps, or seams.

STATIC TEST: Hold weight for 10 min and visually inspect for deformation.

Type \_\_\_\_\_ Size \_\_\_\_\_

Rated Capacity (SWL) \_\_\_\_\_ lb Actual Load Test \_\_\_\_\_ lb

Serial Number \_\_\_\_\_

Qualified Inspector Verify (Load Test) \_\_\_\_\_

Remarks \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# CHAPTER 15

## CONSTRUCTION HOISTING AND RIGGING EQUIPMENT REQUIREMENTS

This chapter outlines the requirements for the safe use of hoisting and rigging equipment on construction projects at DOE installations.

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## 15.1 GENERAL

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The versatility of hoisting and rigging equipment makes it extremely useful on construction projects. Improper and unsafe use, however, can result in serious accidents.

This chapter is designed for use as a stand-alone document and may be used as part of the procurement process. It outlines minimum requirements for the safe use of hoisting and rigging equipment on construction projects at DOE installations.

## 15.2 DEFINITIONS

**APPOINTED:** Assigned specific responsibilities by the employer or the employer's representative.

**AUTHORIZED:** Assigned by a duly constituted administrative or regulatory authority to perform a specific function.

**CRANE, MOBILE:** For the purposes of this chapter, mobile cranes are defined as wheel-mounted cranes, truck cranes, and crawler cranes.

- o A **wheel-mounted** crane consists of a rotating structure with power plant, operating machinery, and boom, mounted on a base or platform equipped with axles and rubber-tired wheels for travel. The base is usually propelled by an engine in the superstructure, but it may be equipped with a separate engine controlled from the superstructure (see Figures 15-1, 15-2, 15-3, 15-4, 15-5, 15-6, 15-7, 15-9, and 15-10).
- o A **truck-mounted crane** consists of a rotating superstructure with power plant that operates machinery and boom, mounted on an automotive truck equipped with a power plant for travel. Commercial truck-mounted cranes are included in this category (see Figures 15-3, 15-5, 15-6, 15-7, 15-9, and 15-10).
- o A **crawler crane** consists of a rotating superstructure with power plant, operating machinery and boom, mounted on a base equipped with crawler treads for travel (see Figures 15-2 and 15-8).

**CRITICAL ITEM:** A part, assembly, component, or piece of equipment designated as critical by the responsible management, because its dropping, upset, or collision could: (a) cause damage that would result in schedule delay; (b) cause

undetectable damage that could jeopardize future operation or the safety of the facility; or (c) result in significant release of radioactivity or other undesirable material. Critical items may include pumps, heat exchangers, piping subassemblies, other primary-system components, fuel assemblies, large radiation-shielded shipping casks, or other items which require special care in handling because of size, weight, installation in close-tolerance receptors, fragility, extreme susceptibility to damage, or other unusual factors.

**CRITICAL SERVICE:** The use of equipment or accessories for hoisting, rigging, or handling critical items.

**DESIGNATED:** Selected or assigned by the employer or the employer's representative as being qualified to perform specific duties.

**DESIGNATED LEADER:** "An individual assigned responsibility for hoisting and rigging activities requiring more than one person".

**FORKLIFT TRUCK:** A high-lift self-loading truck equipped with load carriage and forks for transporting and tiering loads (see Figure 15-11).

**LIFT, CRITICAL:** Lifting of parts, components, assemblies, or other items designated as critical by the responsible management because the effect of dropping, upset, or collision of them could:

- o Cause significant work delay
- o Cause undetectable damage resulting in future operational or safety problems
- o Result in significant release of radioactivity or other undesirable conditions
- o Present a potentially unacceptable risk of personnel injury or property damage.

Note: In the text, use of the imperative voice (as in "Ensure that the load is balanced") or of the term "shall" refers to mandatory actions, whereas the term "should" refers to recommended actions.

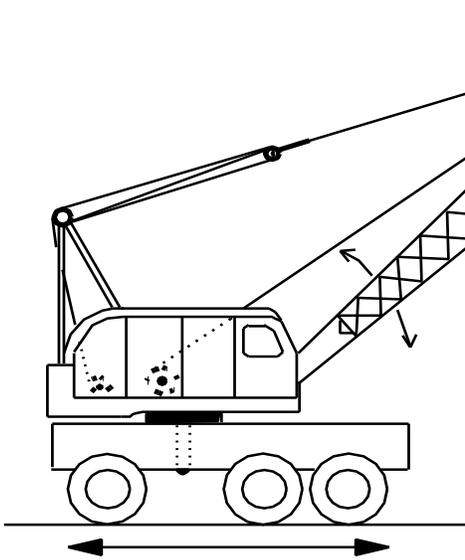


Figure 15-1. Wheel-mounted crane (single control station).

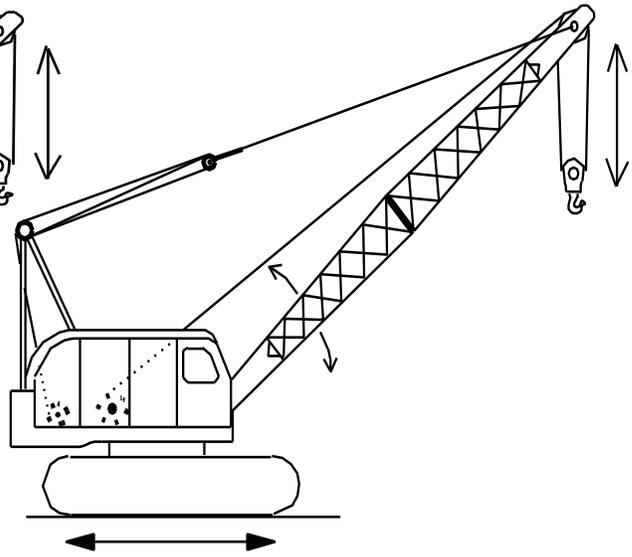


Figure 15-2. Crawler crane

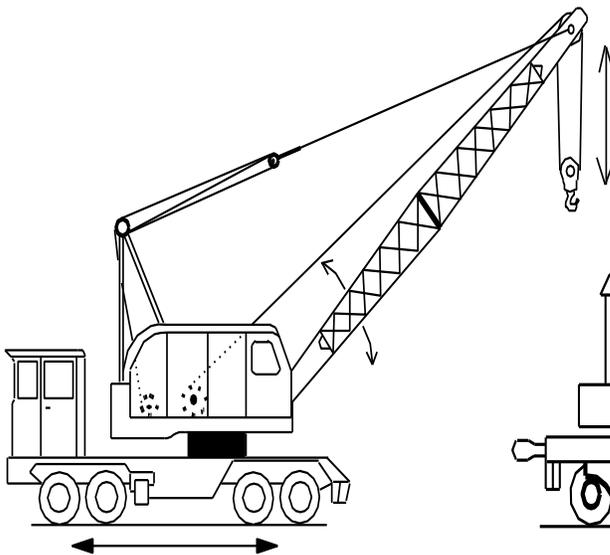


Figure 15-3. Wheel-mounted crane (Multiple control station).

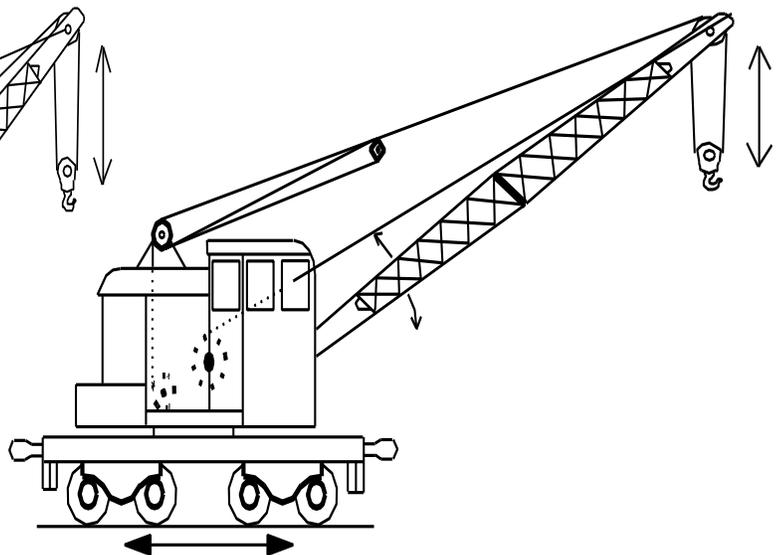
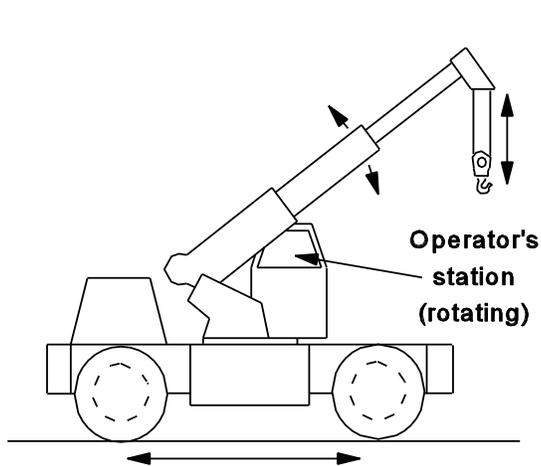


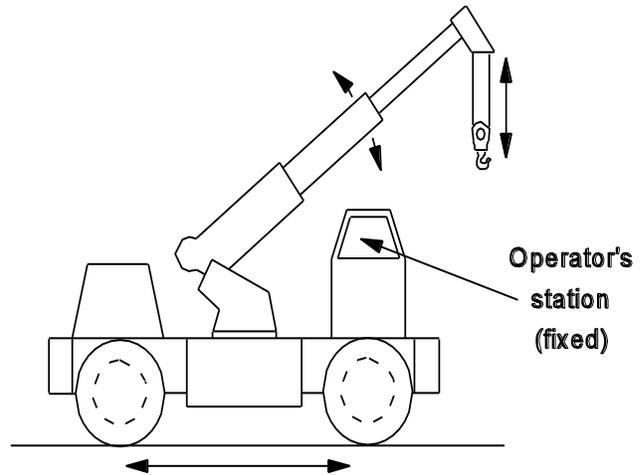
Figure 15-4. Locomotive crane.

General note for Figures 15-5 through 15-10:

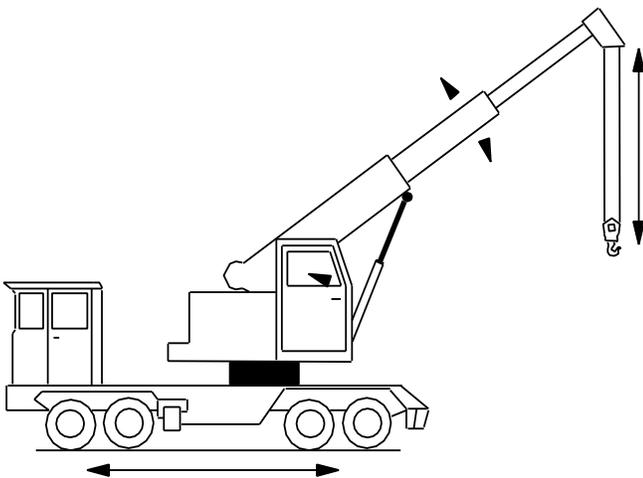
The boom may have a base boom structure of sections (upper and lower) between or beyond which additional sections may be added to increase its length, or it may consist of a base boom from which one or more boom extensions are telescoped for additional length. These illustrations show some types.



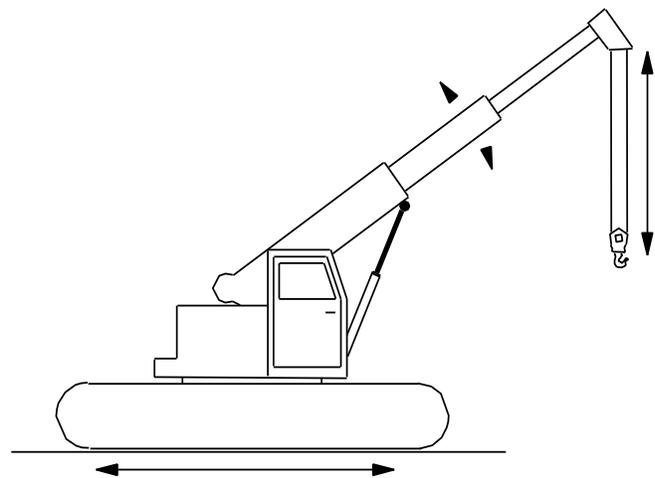
**Figure 15-5. Wheel-mounted crane -- telescoping boom (Single control station).**



**Figure 15-6. Wheel-mounted crane -- telescoping boom (Single control station).**



**Figure 15-7. Wheel-mounted crane -- telescoping boom (Multiple control station).**



**Figure 15-8. Crawler crane -- telescoping boom.**

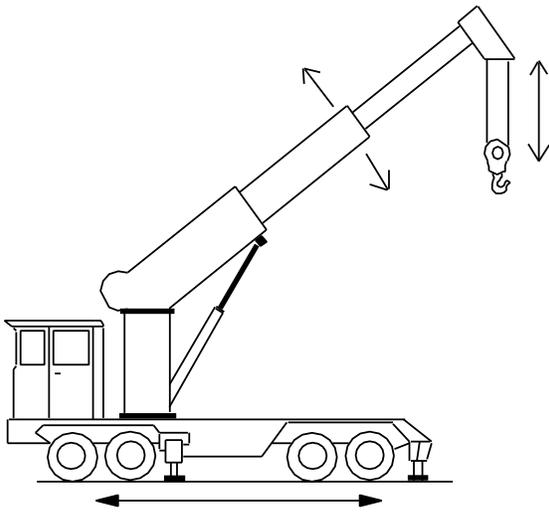


Figure 15-9. Comercial truck-mounted crane -- telescoping boom.

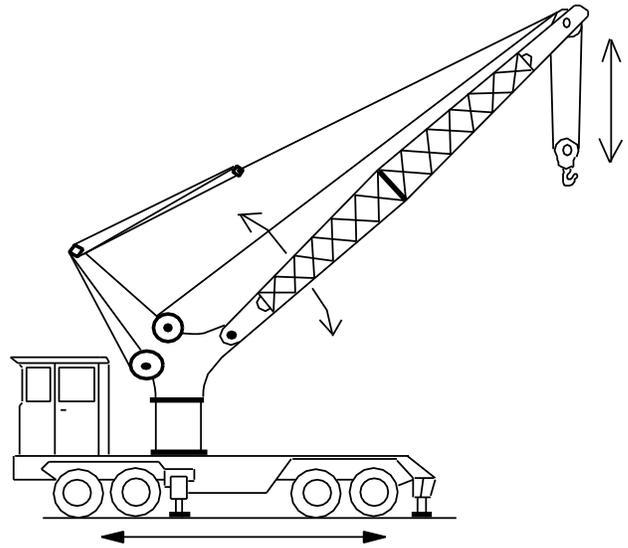


Figure 15-10. Comerical truck-mounted crane -- nontelesoping boom.

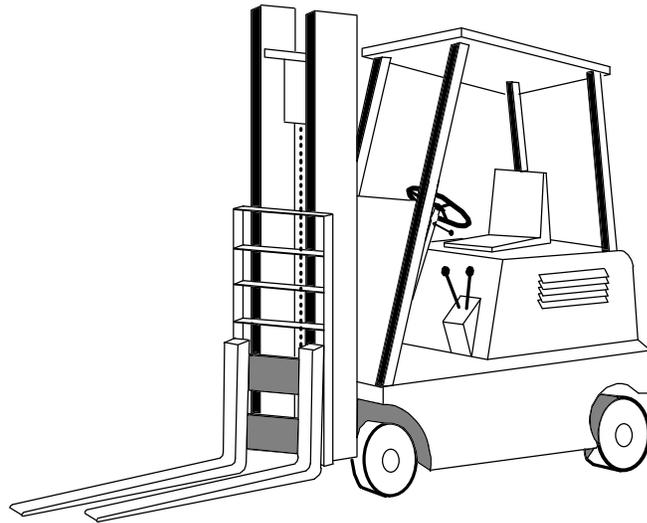


Figure 15-11. High-lift truck, counterbalanced truck, Cantilever truck, rider truck, forlift truck.

**LIFT, ORDINARY:** Any lift not designated as a critical lift.

**PERSON-IN-CHARGE (PIC):** The manager or other responsible person (other than the equipment operator) known to be qualified and appointed to be responsible for the safe handling of critical loads and for the safe handling of noncritical loads in, around, or above spaces in which critical items are located.

**QUALIFIED:** A person, who, by possession of a recognized degree or certificate, or by professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated an ability and competence to solve problems relating to the subject matter and work.

**QUALIFIED ENGINEER/QUALIFIED ENGINEERING ORGANIZATION:** An engineer or engineering organization whose

competence in evaluation of the type of equipment in question has been demonstrated to the satisfaction of the responsible manager.

**QUALIFIED INSPECTOR:** One whose competence is recognized by the authority having jurisdiction and whose qualification to perform specific inspection activities has been determined, verified, and attested to in writing.

**QUALIFIED OPERATOR:** One whose competence to operate equipment safely and effectively (including the ability to accurately spot and control loads) can be demonstrated to and accepted by responsible management.

**QUALIFIED RIGGER:** One whose competence in this skill has been demonstrated by experience accepted as satisfactory by the responsible manager.

## 15.3 PERSONNEL QUALIFICATIONS

### 15.3.1 Qualified Operators of Mobile Cranes

a. Only qualified personnel or trainees, under the direct supervision of qualified personnel, who meet the following physical qualifications and requirements shall be allowed to operate mobile cranes:

1. Be at least 18 years of age.
2. Understand spoken and written English.
3. Have vision of at least 20/30 Snellen in one eye, and 20/50 in the other, with or without corrective lenses.
4. Be able to distinguish colors, regardless of position, if color differentials required for operation.
5. Have adequate hearing, with or without a hearing aid, for a specific operation.
6. Have physical strength, coordination, and sufficient reaction speed to meet the demands of equipment operation.
7. Show no evidence of physical defects or of emotional instability that could be a hazard to themselves or others, or which, in the opinion of the examiner, could interfere with their safe performance; such evidence may be sufficient cause for disqualification. In these cases, medical judgments and test may be required.
8. Show no evidence of being subject to seizures or loss of physical control; such evidence shall be sufficient reason for disqualification. Medical examinations may be required to determine these conditions.
9. Have normal depth perception, field of vision, manual dexterity, coordination, and no tendencies to dizziness or similar potentially hazardous characteristics.
10. Have no detectable or known disease or physical restriction that would render them incapable of safely operating equipment. Where any deficiency of an upper or lower extremity exist, the acceptability of a candidate shall be the decision of the supervisor, after consulting with

the designated physician.

11. Shall successfully pass with a negative result, a substance abuse test. The level of testing will be determined by the standard practice for the industry where the crane is employed and this test shall be confirmed by a recognized laboratory service.

12. Operator physical examinations shall be required every three years or more frequently if supervision deems it necessary.

b. Prior to allowing mobile crane operations at DOE installations, the construction manager shall implement a program or ensure that the construction contractor has an acceptable program to evaluate crane operator qualifications. This program shall include written testing to evaluate operator knowledge and performance (“hands-on”) testing to evaluate operator skills. These tests shall include, but not be limited to applicable elements of the following:

1. Pre-use crane inspection.
2. The crane's specifications, operator's manual, charts (e.g., load charts, work area charts), instrumentation, controls, operator aids, and operating characteristics.
3. Operating procedures under emergency conditions.
4. Set-up, shut-down and parking of the crane.
5. Crane attachments (e.g., jibs, boom extensions, heavy lift equipment).
6. Configurations and loading effects on the crane.
7. Standards, rules and regulations (e.g., hand signals, distances for working around electrical power lines).
8. Rigging practices.
9. Personnel lifting procedures.

NOTE: The means of determining operator qualifications shall be included in the contract documents. Contract documents shall also include requirements for maintenance of testing records.

Consideration should be given to local, state, or federal crane operator licensing requirements within the work jurisdiction as well as certification programs administered by recognized private organizations.

### 15.3.2 Qualified Operators of Forklift Trucks

- a. Physical qualifications shall be based on specific job requirements.
- b. Operators shall be required by the employer to pass a practical operating skill evaluation. Qualification shall be limited to the type of forklift for which the operator is being evaluated.
- c. The actual or simulated operation shall enable operators to demonstrate basic knowledge and skills at a level that ensures the safety of personnel and equipment.

### 15.3.3 Qualified Riggers

Qualified riggers shall meet the following requirements:

- a. Be at least 18 years of age.
- b. Understand spoken and written English.
- c. Have basic knowledge and understanding of equipment-operating characteristics, capabilities, and limitations. Understand rigging principles as applied to the job for which they are to be qualified.
- d. Demonstrate to appropriate management personnel skill in using rigging principles.
- e. Be free of any detectable or known disease or physical restriction that would render them incapable of safe operation or rigging duties. Where any loss or loss of function of an upper or lower extremity exists, the acceptability of the candidate shall be the decision of the supervisor, after consulting with the designated physician.
- f. Have normal depth perception, field of vision, reaction time, manual dexterity, and coordination.

### 15.3.4 Person-in-Charge (PIC)

The PIC shall have the necessary knowledge and experience of the specific type of equipment and

the hazards of critical lifts to direct the safe completion of the operation. The PIC shall understand the rules and procedures implemented at the site to ensure that the following are completed:

- a. Necessary administrative requirements.
- b. Personnel assignments and responsibilities.
- c. Selection of proper equipment/tools.
- d. Recognition and control of hazardous or unsafe conditions.
- e. Job efficiency and safety.
- f. Critical-lift documentation.

In addition, the PIC shall:

- a. Direct operations in the case of an accident.
- b. Exercise authority to start and stop work activities.

### 15.3.5 Designated Leader

The designated leader shall have sufficient knowledge and experience to accomplish the following responsibilities:

- a. Ensure that the personnel involved have received proper and current training and qualification for the procedure.
- b. Ensure that the equipment and accessories specified in the procedure are available.
- c. Survey the lift site for hazardous or unsafe conditions.
- d. Ensure that equipment is properly set up and positioned.
- e. Ensure that a signaller is assigned, if required, and is identified to the operator.
- f. Direct the lifting operation to ensure that the job is done safely and efficiently.
- g. Stop the job when any potentially unsafe condition is recognized.
- h. Direct operations if an accident or injury occurs.

## 15.4 INSPECTION AND TESTING

### 15.4.1 General

a. Only equipment that has been built to nationally recognized manufacturers' standards shall be used at DOE installations. Existing equipment shall be brought to an acceptable level of compliance as determined by the construction management contractor. In some instances, the requirements of this section exceed those of the references and in such instances the requirements of this section shall prevail.

b. Prior to being used at a DOE installation, mobile cranes/boom trucks/forklift trucks shall be inspected and approved for operation by appropriate construction management contractor personnel or those having overall responsibility for ordinary hoisting operations.

c. Equipment with deficiencies that may affect the safety of the operation shall not be allowed to operate at DOE installations. No repairs, modifications, or additions that affect the capacity or safe operation of the equipment shall be made by the contractor without the manufacturer's written approval.

d. Mobile cranes, boom trucks, and forklifts that have left the control of the construction management contractor and are then returned shall be reinspected prior to making a critical lift.

### 15.4.2 Mobile Cranes/Boom Trucks—Inspection

#### 15.4.2.1 Initial Inspection

Prior to initially being used, all new, repaired, or modified cranes shall be inspected by a qualified inspector to ensure their compliance with the applicable provisions of this section. Dated and signed inspection reports shall be kept on file and shall be readily available.

#### 15.4.2.2 Preoperational Check

a. Operators or other designated personnel shall visually inspect items such as the following each day or prior to use if the crane has not been in regular service (records are not required):

1. All control mechanisms for maladjustment interfering with proper operation.

2. Crane hooks and latches for deformation, cracks, and wear.

3. Hydraulic systems for proper oil level.

4. Lines, tanks, valves, pumps, and other parts of air or hydraulic systems for leakage.

5. Hoist ropes for kinking, crushing, birdcaging, and corrosion.

6. All anti-two-block, two-block warning, and two-block damage prevention systems for proper operation.

b. The operator or other designated person shall examine deficiencies and determine whether they constitute a safety hazard.

#### 15.4.2.3 Monthly Inspection

a. The operator or other designated person shall visually inspect the following items for damage, wear, or other deficiency that might reduce capacity or adversely effect the safety of the crane:

1. Critical items such as brakes and crane hooks.

2. Hoist ropes.

b. Lower the hook block to its lowest position and examine it for any condition that could result in an appreciable loss of strength.

c. Hooks for cracks, deformation, damage from chemicals, latch engagement (if provided), and evidence of heat damage.

d. A hoist rope with any of the conditions noted in the replacement criteria in Section 15.4.2.6 shall be removed from service and replaced.

e. Signed and dated inspection records shall be kept on file and shall be readily available.

f. Before the crane is returned to service, correct deficiencies that could reduce its capacity or adversely effect its safety.

**15.4.2.4 Frequent Inspection**

a. The operator or other designated person shall visually inspect the crane at daily to monthly intervals (records not required). These inspections shall, in addition to the requirements of Section 15.4.2.2, "Daily Inspection," include the following:

1. All control mechanisms for maladjustment, excessive wear, or contamination by lubricants or other foreign matter interfering with proper operation.
2. All safety devices for malfunction.
3. Rope reeving for noncompliance with crane manufacturer's recommendations.
4. Electrical apparatus for malfunctioning, signs of potentially harmful deterioration, and accumulation of dirt or moisture.
5. Tires for recommended inflation pressure.
6. Boom sections for structural integrity.

b. The operator or other designated person shall examine deficiencies and determine whether a more detailed inspection is required.

**15.4.2.5 Periodic Inspection**

a. Complete inspections of the crane shall be performed by a qualified inspector at 1- to 12-month intervals, depending on its activity, severity of service, and environment.

b. The qualified inspector shall do the following during periodic inspections:

1. Examine deficiencies and determine whether they constitute a hazard.
2. Keep dated and signed inspection records on file and readily available.
- c. These inspections, in addition to the requirements of Sections 15.4.2.3, "Monthly Inspection" and 15.4.2.4, "Frequent Inspection," shall include the following:

**15.4.2.5.1 Cranes.** Inspect for:

a. Deformed, cracked, or corroded members in the crane structure and the entire boom.

- b. Loose bolts or rivets.
- c. Cracked or worn sheaves and drums.
- d. Hooks damaged from chemicals, deformation, or cracks, or having more than 15 percent in excess of normal throat opening or more than 10 degrees twist from the plane of the unbent hook. (Dye-penetrant, magnetic-particle, or other suitable crack-detecting inspections should be performed at least once a year. See Chapter 13 for additional hook requirements.)
- e. Worn, cracked, or distorted parts such as pins, bearings, shafts, gears, rollers, and locking devices.
- f. Excessive wear on brake and clutch system parts, linings, pawls, and ratchets.
- g. Load, boom angle, and other indicators over their full ranges for any significant inaccuracies.
- h. Gasoline, diesel, electrical, or other power plants for improper performance or noncompliance with safety requirements.
- i. Radiators and oil coolers for leakage, improper performance, or blockage of air passages.
- j. Excessive wear of chain drive sprockets and excessive chain stretch.
- k. Travel steering, braking, and locking devices, for malfunctioning.
- l. Excessively worn or damaged tires.
- m. Rust on piston rods and control valves when crane has been idle.
- n. Inspect hydraulic and pneumatic hose, fittings, and tubing for:
  1. Evidence of leakage at the surface of the flexible hose or its junctions with the metal couplings.
  2. Blistering or deformation of the outer covering of the hydraulic or pneumatic hose.
  3. Leakage at threaded or clamped joints that cannot be eliminated by normal tightening or recommended procedures.
  4. Evidence of excessive abrasion or

scrubbing on the outer surface of a hose, rigid tube, or fitting (means shall be taken to eliminate the interface of elements in contact or otherwise protect the components).

**15.4.2.5.2 Hydraulic and Pneumatic Pumps.** Inspect for:

- a. Loose bolts or fasteners.
- b. Leaks at joints between sections.
- c. Shaft seal leaks.
- d. Unusual noises or vibration.
- e. Loss of operating speed.
- f. Excessive heating of the fluid.
- g.. Loss of pressure.

**15.4.2.5.3 Hydraulic and Pneumatic Valves.** Inspect for:

- a. Cracks in valve housing.
- b. Improper return of spool to neutral position.
- c. Leaks at spools or joints.
- d. Sticking spools.
- e. Failure of relief valves to attain correct pressure setting (relief valve pressures shall be checked as specified by the manufacturer).

**15.4.2.5.4 Hydraulic and Pneumatic Cylinders.** Inspect for:

- a. Drifting caused by fluid leaking across the position.
- b. Rod seal leakage.
- c. Leaks at welded joints.
- d. Scored, nicked, or dented cylinder rods.
- e. Dented case (barrel).
- f. Loose or deformed rod eyes or connecting joints.

**15.4.2.5.5 Hydraulic Filters.**

Inspect hydraulic filters for evidence of rubber

particles on the filter element that may indicate hose, “O” ring, or other rubber-component deterioration. Metal chips or pieces on the filter may denote failure in pumps, motors, or cylinders. Further checking will be necessary to determine the origin of the problem before corrective action can be taken.

**15.4.2.5.6 Wire Ropes.**

a. A qualified inspector shall inspect all wire ropes at least annually. More frequent intervals shall be as determined by a qualified person and shall be based on such factors as expected rope life as determined by severity of environment, percentage of capacity lifts, frequency rates of operation, and exposure to shock loads. The qualified inspector shall carefully note any deterioration, such as described below, that results in appreciable loss of original strength and determine whether further use of the rope constitutes an acceptable risk. This inspection shall include examination of the entire rope length without detaching it from the drum.

1. Reduction of rope size below nominal diameter, whether due to loss of core support, internal or external corrosion, or wear of outside wires (see Table 15-1).

2. A number of broken outside wires and the distribution or concentration of such broken wires.

3. Worn outside wires.

**Table 15-1. Maximum allowable rope reductions.**

Rope diameter	Maximum allowable reduction from nominal diameter
Up to 5/16 in. (8 mm)	1/64 in. (0.4 mm)
Over 5/16 in. to 1/2 in. (13 mm)	1/32 in. (0.8 mm)
Over 1/2 in. to 3/4 in. (19 mm)	3/64 in. (1.2 mm)
Over 3/4 in. to 1 1/8 in. (29 mm)	1/16 in. (1.6 mm)
Over 1 1/8 in. to 1 1/2 in. (38 mm)	3/32 in. (2.4 mm)

4. Corroded or broken wires at end connections.

5. Corroded, cracked, bent, worn, or improperly applied end connections.

6. Kinking, crushing, cutting, or unstranding.

b. The qualified inspector shall take care when inspecting running rope where rapid deterioration could occur, such as in the following:

1. Sections in contact with saddles, equalizer sheaves, or other sheaves where rope travel is limited.

2. Sections of the rope at or near terminal ends where corroded or broken wires may protrude.

c. The qualified inspector shall take care when inspecting certain ropes such as the following:

1. Rotation-resistant ropes, because of their higher susceptibility to damage. The internal deterioration of rotation-resistant ropes may not be readily observable.

2. Boom hoist ropes, because of the difficulty of inspection and the important nature of these ropes.

d. No precise rules can be given for determining the exact time to replace wire rope because many variables are involved. Safety in this respect depends largely on the use of good judgment by an appointed person in evaluating remaining strength in a used rope, after allowance for deterioration disclosed by inspection. Safety of rope operation depends on this remaining strength.

e. Conditions such as the following shall be sufficient reason for questioning rope safety and considering replacement:

1. In running ropes, six randomly distributed broken wires in one rope lay, or three broken wires in one strand in one rope lay.

2. In standing ropes, more than two broken wires in one lay in sections beyond end connections or more than one broken wire at an end connection.

3. In rotation resistant ropes, two randomly distributed broken wires in six rope diameters or four randomly distributed broken wires in thirty rope diameters.

4. One outer wire broken at the point of contact with the core of the rope that has worked its way out of the rope structure and protrudes or loops out from the rope structure; additional inspection of this section is required.

5. Wear of one-third the original diameter of outside individual wires.

6. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.

7. Evidence of heat damage from any cause.

8. Reduction from nominal diameter greater than those listed in Table 15-1.

f. All rope that has been idle for a month or more due to shutdown or storage of a crane on which it is installed shall be inspected before it is placed in service. This inspection shall be for all types of deterioration and shall be performed by an appointed person whose approval shall be required before further use of the rope. A written and dated report of the rope condition shall be filed.

g. To establish data as a basis for judging the proper time for replacement, maintain a continuing inspection record covering the points of deterioration listed above.

h. Ensure that replacement rope is the same size, grade, and construction as recommended by the crane manufacturer, unless otherwise recommended by a rope or crane manufacturer due to actual working condition requirements.

i. Never use discarded rope for slings.

#### **15.4.2.5.7 Load Hooks/Load Blocks.**

Load hooks/load blocks that have been changed-out shall be inspected by a qualified inspector before the crane is returned to service. Inspection records shall be retained throughout the service life of the hook or load block and shall be readily available.

**15.4.2.6 Cranes Not in Regular Use**

- a. A crane that has been idle for 1 month or longer but less than 6 months shall be given an inspection according to requirements of Section 15.4.2.4, "Frequent Inspection," before it is placed in service.
- b. A crane that has been idle for more than 6 months shall be given a complete inspection according to the requirements of Section 15.4.2.5, "Periodic Inspection," before it is placed in service.
- c. Standby cranes shall be inspected at least semiannually, according to the requirements of Section 15.4.2.5. Cranes exposed to adverse environments should be inspected more frequently.

**15.4.3 Mobile Cranes/Boom Trucks—Testing**

- a. Prior to their initial use, all cranes in which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector. The replacement of rope is excluded from this requirement. However, a functional test of the crane under a normal operating load should be made before the crane is put back in service.
- b. Test weights shall not exceed 110 percent of the rated capacity and shall be accurate to within -5 percent, +0 percent of stipulated values.
- c. The inspector shall furnish a written report showing test procedures and confirming the adequacy of repairs or alterations. Test reports shall be kept on file and shall be readily available to appointed personnel.
- d. The following shall also be tested as applicable during initial testing:
  1. Load lifting and lowering mechanisms.
  2. Boom lifting and lowering mechanisms.
  3. Boom extension and retraction mechanism.
  4. Swinging mechanism.
  5. Travel mechanism.

6. Safety devices.

Load tests shall not be conducted in locations where the lift meets the definition of critical lift given in Section 15.2, "Definitions."

**15.4.4 Forklift Trucks—Inspection**

- a. Prior to initial use, all new, modified, or extensively repaired forklifts shall be inspected by a qualified inspector to ensure compliance with the provisions of this section.
- b. Operators or other designated personnel shall regularly inspect the items listed in the following paragraphs.
  1. Inspect brakes, steering mechanisms, control mechanisms, warning devices, lights, governors, lift-overload devices, guards, and safety devices regularly and maintain them in a safe-operating condition.
  2. Carefully and regularly inspect all parts of lift and tilt mechanisms and frame members and maintain them in a safe-operating condition.
  3. For special trucks or devices that are designed and approved for operation in hazardous areas, ensure that the original, approved safe-operating features are preserved by maintenance.
  4. Check fuel systems for leaks and for the condition of the parts. Give special consideration in case of a leak in the fuel system. Take action to prevent use of the truck until the leak has been corrected.
  5. Inspect all hydraulic systems and maintain them in conformance with good practice. Check tilt cylinders, valves, and other similar parts to ensure that drift or leakage has not developed to the extent that it would create a hazard.
  6. Maintain instruction plates for capacity, operation, and maintenance in legible condition.
  7. Inspect batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections and maintain them in conformance with good practice. Pay special

attention to the condition of electrical insulation.

### 15.4.5 Forklift Trucks—Testing

a. Prior to their initial use, all forklifts in which load-sustaining parts have been modified, replaced, or repaired shall be load-tested by a qualified inspector or under the direction of that inspector.

1. Test loads shall not exceed 100 percent of the rated capacity.
2. Test weights shall be accurate to within -5 percent, +0 percent of stipulated values.
3. Load slippage shall not be greater than 3 in. vertically and 1 in. horizontally at the cylinder during a static test of at least 10 min duration.
4. Load-test records shall be maintained and shall be made available for examination by the construction management contractor.

b. A load test shall not be conducted in locations such that the lift meets the definition of critical lift in Section 15.2.

### 15.4.6 Slings—Inspection

#### 15.4.6.1 Wire Rope

a. Users or other designated personnel shall visually inspect all wire-rope slings each day prior to use, carefully noting any deterioration that could result in an appreciable loss of original strength and determining whether further use of the sling would constitute a safety hazard.

b. Slings shall be immediately removed from service if any of the following conditions are present:

1. Ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay.
2. Wear or scraping of one-third the original diameter of outside individual wires.
3. Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure.
4. Evidence of heat damage from any

cause.

5. End attachments that are cracked, deformed, or worn.

6. Hooks that have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

7. Corrosion of the rope or end attachments.

#### 15.4.6.2 Synthetic Web Slings

a. Users or other designated personnel shall visually inspect all synthetic-web slings each day prior to use, carefully noting any deterioration that could result in an appreciable loss of original strength and determining whether further use of the sling would constitute a safety hazard.

CAUTION: Tiedown and/or ratchet straps shall not be used as synthetic-web slings. Only synthetic-web slings constructed from webbing approved for sling construction by the manufacturer or other qualified person shall be used at DOE locations.

b. A synthetic-web sling shall be removed from service if any of the following defects are visible:

1. Acid or caustic burns.
2. Melting or charring of any part of the surface.
3. Snags, punctures, tears, or cuts.
4. Broken or worn stitches.
5. Wear or elongation exceeding the amount recommended by manufacturers.
6. Distortion of fittings.

c. For other apparent defects that cause doubt as to the strength of the sling, refer to the manufacturer for determination of whether continued use would constitute a safety hazard.

#### 15.4.6.3 Alloy Steel Chain

a. Users or other designated personnel shall visually inspect all steel-chain slings each day before they are used as follows:

1. Conduct a link-by-link inspection for the following defects: bent or stretched links, cracks in any section of link, scores, or abrasions tending to weaken the rings or hooks. Reject if discovered.

2. Check rings and hooks for distortion, cracks in weld areas, corrosion, scores, or abrasions tending to weaken the ring or hooks. Reject if discovered.

3. Perform inspection on an individual-link basis. If any link does not hinge freely with the adjoining link, remove the assembly from service.

b. Remove from service assemblies with deformed master links or coupling links.

c. Remove from service assemblies if hooks have been opened more than 15 percent of the normal throat opening measured at the narrowest point or twisted more than 10 degrees from the plane of the unbent hook.

d. Do not straighten deformed hooks or other attachments on the job. Assemblies with such defects shall be reconditioned by the manufacturer.

e. Remove from service assemblies with cracked hooks or other end attachments; assemblies with repairable defects shall be reconditioned or repaired prior to being returned to service.

f. If wear exceeds the values shown in Table 15-2, remove the assembly from service.

**Table 15-2. Maximum allowable wear at any point of link.**

Chain size (in.)	Maximum allowable wear (in.)
1/4	3/64
3/8	5/64
1/2	7/64
5/8	9/64
3/4	10/64
7/8	11/64
1	12/64
1-1/4	16/64

NOTE: For other sizes, consult chain or sling manufacturer.

## 15.4.7 Slings—Testing

### 15.4.7.1 Wire Rope

a. All swaged and poured socket sling assemblies shall be certified as having been proof-tested. All other sling assemblies shall be proof-tested when specified by the purchaser.

b. As a minimum, the proof load shall be equal to the rated capacity but shall not exceed:

1. 125 percent of the vertical rated capacity for single-leg, hand-tucked slings.

2. 200 percent of the vertical rated capacity for mechanical-splice single-leg slings and endless slings.

c. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be either 200 percent for mechanical-spliced or 125 percent for hand-tucked splice times the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

d. Welded end attachments shall not be used unless proof-tested at 2 times the rated capacity prior to initial use.

e. Test loads described above shall be accurate to within -5 percent, +0 percent of stipulated values. A written letter of certification by the manufacturer or a pull test witnessed and certified in writing by a qualified person is acceptable.

### 15.4.7.2 Synthetic Web Slings

a. When specified by the purchaser, web slings of all types shall be certified as having been proof-tested prior to initial use.

1. The proof load for single-leg slings and endless slings shall be 200 percent of the vertical rated capacity prior.

2. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent times the force applied by the combined legs.

b. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

#### 15.4.7.3 Alloy Steel Chain

a. Single-leg and endless alloy-steel chain slings shall be certified as having been proof-tested to 200 percent of the rated capacity prior to initial use.

b. The proof load for multiple-leg bridle slings shall be applied to the individual legs and shall be 200 percent of the vertical rated capacity of a single-leg sling. Master links to which multiple-leg slings are connected shall be proof-loaded to 200 percent multiplied by the force applied by the combined legs.

c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values. Either certification by the manufacturer or a pull test certified by a qualified person is acceptable.

#### 15.4.8 Rigging Accessories— Inspection

a. Users or other designated personnel shall inspect shackles, rings, eyebolts, lifting bars, rigging assemblies, and hooks at the beginning of each shift in which they are to be used, as follows:

1. Inspect shackles, rings, and similar items for wear, corrosion, spreading, and deformation. Replace them if deformation exceeds 15 percent of their new condition. Replace shackle pins if they show any sign of failure in shear.

2. Inspect lifting bars and spreaders for signs of failure in bending; replace if permanently bent more than 1/2 in. in 10 ft or if twisted more than 5 degrees out of the original plane. Examine hook-attachment welds for cracks and signs of failure in tension.

3. Hooks having any of the following deficiencies shall be removed from service until repaired or replaced:

- i. Cracks.
- ii. Wear exceeding 10 percent of the original dimension.
- iii. A bend or twist exceeding 10 degrees from the plane of the unbent hook.
- iv. Increase in throat opening exceeding 15 percent from the new condition.

4. If a latch is provided and it becomes inoperative because of wear or deformation or fails to fully bridge the throat opening, remove the hook from service until the latch has been repaired or replaced.

NOTE: If hooks are painted, a visual inspection should take the coating into consideration. Surface variations can disclose evidence of heavy or severe service. In such instances, the surface condition may call for stripping the paint.

#### 15.4.9 Rigging Accessories— Testing

a. Tackle assemblies, handling fixtures, and rigging accessories for critical-lift service shall have an initial proof-load test of 2 times the rated capacity. The tackle shall be proof-tested prior to making a critical lift if proof-testing cannot be verified.

b. Tackle assemblies, handling fixtures, and rigging accessories that have been modified or extensively repaired shall be proof-tested again to 2 times the rated capacity prior to making a critical lift.

c. Test loads shall be accurate to within -5 percent, +0 percent of stipulated values.

## 15.5 OPERATION

The following shall apply to all personnel involved in construction hoisting and rigging operations.

a. An appointed person shall classify each lift into one of the DOE categories (ordinary or critical), prior to planning the lift.

b. A lift shall be designated as a critical lift if collision, upset, or dropping could result in any one of the following:

1. Damage that would result in unacceptable delay to schedule or other significant program impact such as loss of vital data.

2. Significant release of radioactive or other hazardous material or other undesirable conditions.

3. Unacceptable risk of personnel injury or significant adverse health impact (onsite or offsite).

4. Undetectable damage that would jeopardize future operations or the safety of a facility.

c. A lift should also be designated as critical if the load requires exceptional care in handling because of size, weight, close-tolerance installation, high susceptibility to damage, or other unusual factors.

### 15.5.1 Conduct of Operator

a. Ensure proper functioning of tires, horns, lights, batteries, controllers, lift systems (including load-engaging means, limit switches, etc.), brakes, and steering mechanisms. If at any time a lifting device is found to be defective or in any way unsafe, report it immediately to appropriate management and take the unit out of service until it has been restored to safe-operating condition or a determination has been made by the construction management contractor that the deficiency will not adversely affect the operation of the unit.

b. The safety of personnel and equipment is the first priority. Report or correct any unsafe condition immediately.

c. If the operator's visibility is impaired by dust, darkness, snow, fog, or rain, strict supervision of the operation must be exercised,

and if necessary, the equipment shall be withdrawn from service.

d. Be alert while operating and always keep your eye on the load. If your attention must be directed elsewhere, discontinue operation first. Keep a signaler in full view if you cannot see the load at all times.

e. Never operate the machine or allow anyone to operate it unless that person is thoroughly familiar with the machine, its operation, and proper care.

f. Be a good housekeeper. Keep the work area free of oil, grease, rags, buckets, barrels, and other hazards. Keep loose parts in a tool box. Use only nonflammable solutions for cleaning. Be sure shoe soles are clean and dry before operating brakes.

g. Replace all missing or broken guards and panels.

h. Never tamper with safety devices.

i. Have a fire extinguisher on hand and know how to use it. Be sure that it is checked regularly (at least monthly) to ensure it is in proper working order.

j. Check the motion controls for proper functioning at the start of each shift or prior to use if the crane has not been in regular service.

k. Make certain that no one is working on or close to the machine before starting the engine or beginning to move. Accessible areas within the swing radius of the rear of the rotating superstructure of the crane, either permanently or temporarily mounted, shall be barricaded in such a manner as to prevent an employee from being struck or crushed by the crane.

l. Use caution when refueling. Stop the engine; do not permit smoking within 25 ft; never refuel near an open flame. Keep metal funnels in contact with the filler tube to prevent static spark. Turn off the heater before fueling.

m. Use both hands to mount and dismount. Never get on or off a moving machine, and never jump off, even if the machine is stationary.

n. Hand signals from only one person shall be obeyed. However, obey a STOP signal

*regardless of who gives it.* Use the standard signals shown in Figure 15-12.

o. Many machines have ratings limited by factors other than machine stability. Never exceed the rated capacity.

p. Make a dry run in confined areas to help determine the safest way to operate under existing conditions.

q. Check loads before moving them. First, determine the load weight and check it against the capacity chart. Be sure the load is well secured and the hoist ropes are not kinked. Ensure that the hoist ropes are vertical and avoid sudden starts and stops.

### 15.5.2 Mobile Cranes/Boom Trucks

a. Never use signs of tipping to determine if a load is within a crane's capacity. Operating by the "seat of the pants" is an unacceptable practice.

b. Know the rated capacity of the crane. A safe lift depends on boom length, boom angle, and working radius. Follow these suggestions to avoid structural failure or tipping:

1. Know the radius of the load.

Remember that the radius is measured from center of rotation, not from the boom foot pins.

2. Always operate within the rated capacity of the machine.

3. Subtract the weight of hooks, blocks, and any other material-handling devices (slings, shackles, spreader bars, etc.) from the gross capacity of the crane to determine if the load can be lifted safely.

4. Load chart ratings are based on operating the machine on firm, level ground. Outriggers shall be fully extended and lowered so that all wheels are clear of the ground, unless otherwise specified on the manufacturer load charts for the crane. Otherwise, "on rubber" load charts shall be used.

5. Avoid rapid changes in velocity while hoisting, swinging, or lowering the load; these can cause overloads when operating at or near the crane's capacity.

6. Do not lift large, heavy loads in strong winds. Wind loading can be critical depending on

boom length, boom angle, bulkiness of the load, wind direction, and wind velocity.

7. In the absence of crane manufacturer's instructions regarding maximum wind speeds for operation, any wind speed in excess of 25 mph shall be reason to remove the crane from service.

c. Always use the shortest boom possible, and observe these precautions with any boom length:

1. Make only vertical lifts. Never pull the load sideways.

2. Keep speed slow in lifting, lowering, and stopping loads.

3. Do not let the load strike the boom or outriggers and never allow a crane boom to hit or touch any structure. (Boom contact could dent or bend the lower boom chords and may cause a total boom collapse.) Boom contact with any object shall require an engineering evaluation prior to putting the crane back in service. Damage to the crane sustained during operation shall be repaired according to manufacturer's specifications using certified welders. A reinspection or load test is required after repairs are complete, as is a recertification by the construction management contractor at the subcontractor's expense indicating that the unit can return to service.

4. Allow maximum clearance between the hook block and boom point sheaves.

5. Keep near-capacity loads as close to the ground as possible.

d. Rotate the crane slowly to avoid an outward swing of the load. Attach a tag line to the load to control the swing.

e. Keep the boom high enough to swing clear of the cab when rotating the crane on truck-mounted units.

f. Watch for boom kickback. Never operate with the boom at a higher angle than shown on the capacity chart.

g. Avoid "two-blocking," which is caused when the hook block collides with boom-point sheaves. Continuous pull on hoist ropes can break the ropes or might pull the boom over the cab. On hydraulically telescoping booms, be sure to play out the hoist rope when extending and reel in the hoist rope when retracting.

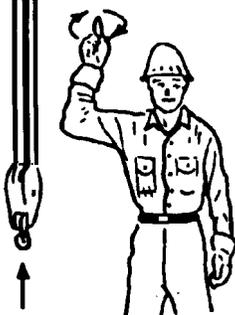
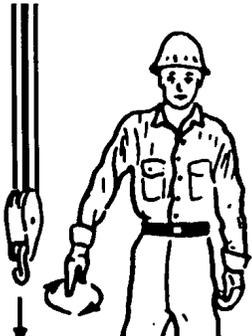
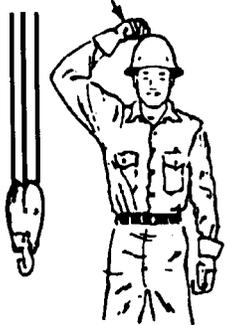
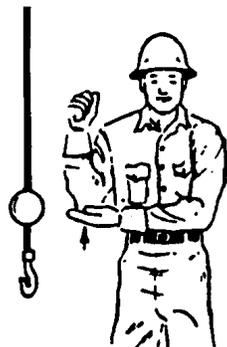
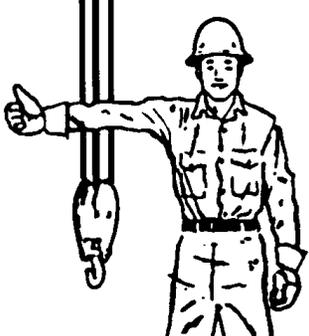
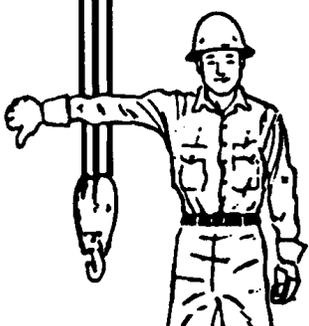
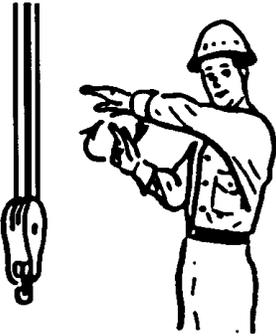
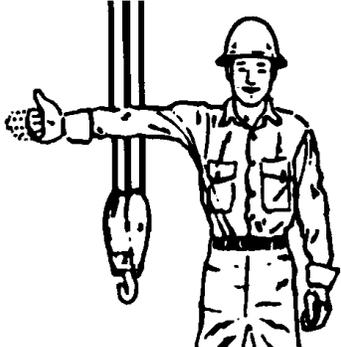
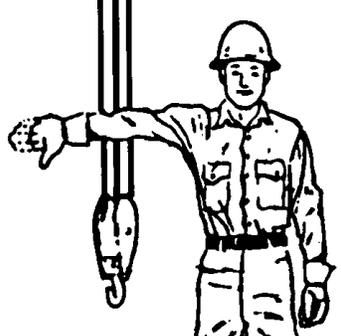
		
<p>HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circles.</p>	<p>LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.</p>	<p>USE MAIN HOIST. Tap fist on head, then use regular signals.</p>
		
<p>USE WHIPLINE (Auxiliary Hoist). Tap elbow with one hand, then use regular signals.</p>	<p>RAISE BOOM. Extend arm, fingers closed, thumb pointing upward.</p>	<p>LOWER BOOM. Extend arm, fingers closed, thumb pointing downward.</p>
		
<p>MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless above hand giving the motion signal. (Hoist slowly shown as example.)</p>	<p>RAISE THE BOOM AND LOWER THE LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.</p>	<p>LOWER THE BOOM AND RAISE THE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.</p>

Figure 15-12. Standard hand signals for controlling crane operation.

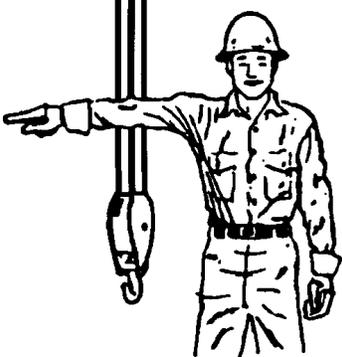
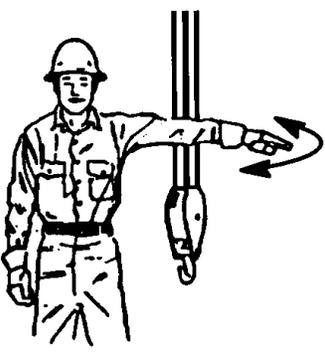
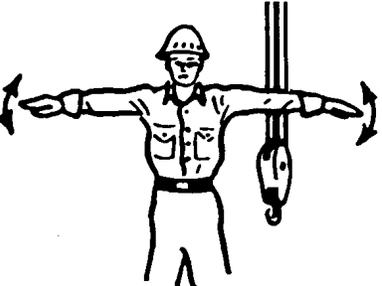
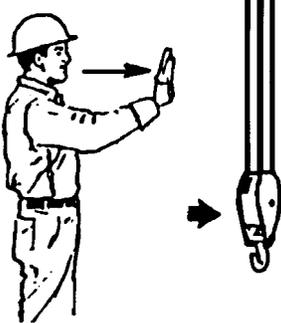
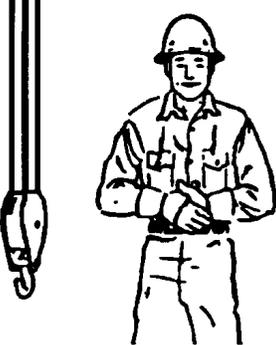
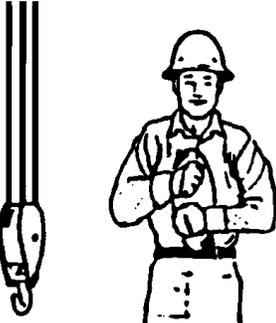
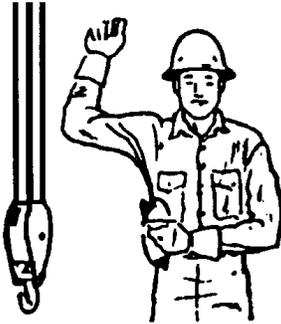
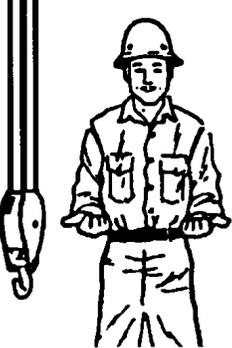
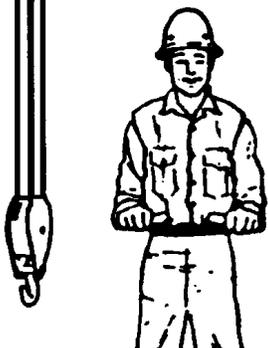
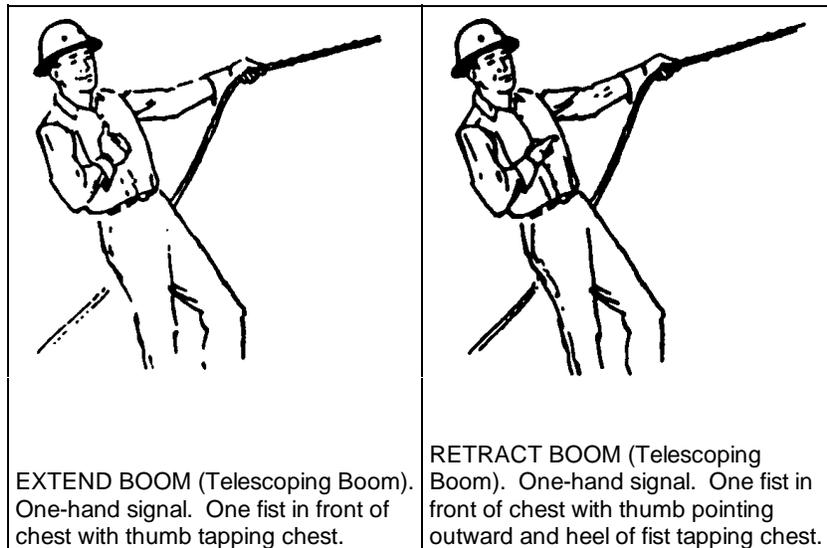
 <p>SWING. Extend arm, point with finger in direction of swing of boom.</p>	 <p>STOP. Extend arm, palm down; move arm back and forth horizontally.</p>	 <p>EMERGENCY STOP. Extend both arms, palms down, and move arms back and forth horizontally.</p>
 <p>TRAVEL. Extend arm forward, hand open and slightly raised; make pushing motion in direction of travel.</p>	 <p>DOG EVERYTHING. Clasp hands in front of body.</p>	 <p>TRAVEL (Both Tracks). Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward (for land cranes only).</p>
 <p>TRAVEL (One Side Track). Lock the track on side indicated by raised fist. Travel opposite track indicated by circular motion of other fist, rotated vertically in front of body (for land cranes only).</p>	 <p>EXTEND BOOM (Telescoping Booms). Hold both fists in front of body, thumbs pointing outward.</p>	 <p>RETRACT BOOM (Telescoping Booms). Hold both fists in front of body, thumbs pointing toward each other.</p>

Figure 15-12. (continued).



**Figure 15-12. (continued).**

### 15.5.2.1 Attaching the Load

- a. Ensure that the hoist rope is free of kinks or twists and is not wrapped around the load.
- b. Attach the load to the load-block hook with slings or other approved devices.
- c. Make certain that the sling clears all obstacles.

### 15.5.2.2 Moving the Load

- a. Before moving the load, make certain that it is well secured and properly balanced in the sling or lifting device before lifting it more than a few inches.
- b. Before starting to hoist, note the following conditions:
  1. Multiple-part lines shall not be twisted around each other.
  2. The hook shall be positioned over the load in such a manner as to prevent swinging when the load is lifted.
  3. If there is a slack-rope condition, determine that the rope is properly seated on the drum and is in the sheaves.
- c. Test stability before lifting heavy loads. Check outrigger footing. Lift load slightly off the

ground and stop. Check the machine for movement and check to be sure the brakes are holding. Never use machine stability to determine capacity. If there are any indications of tipping, the machine is already overloaded for that working radius.

d. Do not use cranes for side pulls except when specifically authorized by a designated person who has determined that the stability of the crane is not endangered and that the parts of the crane will not be overstressed.

e. Do not hoist, lower, or travel while anyone is on the load or hook, except as noted in Section 15.5.2.6, "Lifting Personnel."

f. Do not move loads above people.

g. Test the brakes each time a load approaching the rated capacity is handled by raising the load a few inches and applying the brakes.

h. Power down when lowering loads. When lowering heavy loads, keep the hoist brakes as reserve. Use a safety pawl on the boom-hoist drum when not lowering.

i. Do not lower the load below the point where less than two full wraps of rope remain on the hoist drum.

j. Do not leave your position at the controls while the load is suspended unless required to do

so by an approved emergency procedure.

k. Work on suspended loads is prohibited under normal conditions. When the responsible manager decides that is necessary to work on suspended load, guidelines for ensuring safety of the work shall be established through consultation with the appropriate safety organization. Suspended loads that must be worked on shall be secured against unwanted movement.

l. Tag lines should be used as required to guide, snub or otherwise control the load.

### 15.5.2.3 Traveling the Machine

a. Secure the boom and hook block.

b. Check bridges before crossing; make sure they will support the weight of the machine.

c. Check river depths before fording.

d. Check clearances under overpasses, overhead lines, or any overhead obstruction. When side clearances are tight, post a lookout and be sure there is clearance for tail swing.

e. When traveling with a load, snub the load to prevent swaying if possible. Never travel with near-capacity loads.

f. Never travel a rubber-tired unit with a load over the side.

g. On soft surfaces, always move with the load behind; this helps to raise the leading end of the tracks and makes traveling safer.

h. Always set swing brakes when the unit is idle or holding loads for a period of time, especially on slopes. If swinging during travel is necessary, engage the swing-jaw clutch before releasing brakes.

i. Never back up until everyone is clear of the machine, and use a signaler when backup alarms are not provided.

j. Avoid tipping by never backing the crane while carrying a maximum load.

k. For long moves, position the boom in the direction of travel.

l. Block treads when moving uphill to prevent downhill movement before shifting steering

clutches.

m. Lock the turntable prior to highway travel. Use a house lock or swing brake, and lower boom into the rack to prevent swing.

n. When loading machine on the trailer, always use a ramp; if a ramp is not available, use blocking to build one.

o. Be familiar with the equipment and its proper care. If adjustments or repairs are necessary, promptly report this to the appropriate level of management.

p. Test all controls at the start of a new shift. If any controls fail to operate properly, adjust or repair them before operations are begun.

q. Block under the boom before disassembling. Never stand on or under the boom during this work.

r. Before disconnecting oil lines, if machine has hydraulic controls, be sure to place the boom on the ground or in the boom rest, then move the pedals and control levers to equalize pressures within the cylinders. Always release any air supercharge on the hydraulic reservoir and shut off the engine (or declutch pumps) before disconnecting oil lines.

s. Do not reach into hydraulic-boom holes unless the sections are securely anchored together.

### 15.5.2.4 Operating Near Power Lines and Transmission Towers

It is recognized that operating mobile cranes where they can become electrified from electric power lines is an extremely hazardous practice. It is advisable to perform the work so there is no possibility of the crane, load line, or load becoming a conductive path, (Figure 15-13).

The following steps shall be taken to minimize the hazard of electrocution or serious injury as a result of contact between the energized power lines and the crane, load line, or load:

a. The (electric) Power Marketing Administrations in DOE may deviate from the requirements of Table 15-3, providing the work is done according to line management-approved procedures that do not conflict with statutory regulations or approved variances from these regulations.

b. Any overhead wire shall be considered to be an energized line unless and until the person owning the line or the electrical utility authorities indicate that it is not an energized line.

c. Durable signs shall be installed at the operator's station and on the outside of the crane, warning that electrocution or serious bodily injury may occur unless a minimum clearance of 10 ft (3.1 m) is maintained between the crane or the load being handled and energized power lines. Greater clearances are required because of higher voltage as stated in Table 15-3. These signs shall be revised but not removed when a local jurisdiction requires greater clearances.

d. Exercise caution when working near overhead lines having long spans as they tend to move laterally or vertically due to the wind, which could cause them to breach the safety zone.

e. Cranes shall not be used to handle materials stored under electric power lines unless any combination of the boom, load, load line, or machine component cannot enter the prohibited zone.

f. Crane operators shall not rely on the coverings of wires for their protection.

#### **15.5.2.4.1 Crane Operation Near De-energized and Grounded Electric Power Lines**

This is the preferred condition under which the operation can be performed safely. The hazard of injury or death due to electrocution has been removed. The following steps shall be taken to assure de-energization of the power lines has occurred:

a. The power company or owner of the power lines shall de-energize the lines.

b. The lines shall be visibly grounded to avoid electrical feedback and appropriately marked at the job-site location.

c. A qualified representative of the owner of the lines or a designated representative of the electrical utility shall be on site to verify that steps (a) and (b) have been completed and that the lines are not energized.

#### **15.5.2.4.2 Power Lines Energized, Crane Operating Less than Erected/Fully Extended Boom Length away from the Prohibited Zone (see Figure 15-14)**

a. An on-site meeting between project management and a qualified representative of the owner of the lines or a designated representative of the electrical utility shall take place to establish the procedures to safely complete the operations.

b. The specified clearance between the power lines and the crane, load line, and load shall be maintained at all times as specified in Table 15-3.

c. Load control, when required, shall utilize tag lines of a non-conductive type. signaller indicates it is safe to do so.

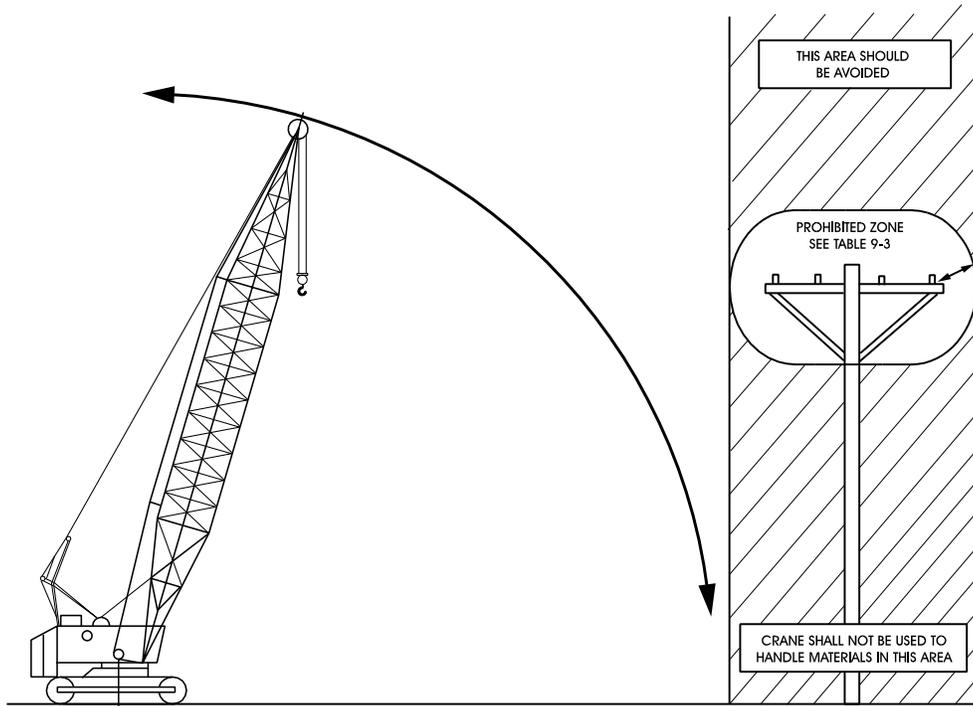
d. Operation of boom and load over electric power lines is extremely dangerous, due

e. A designated signaller, whose sole responsibility is to verify that the required clearance is maintained shall be in constant contact with the crane operator.

f. No one shall be permitted to touch the crane or the load unless the designated to perception of distance and multiple contact points as viewed from the position of the operator and /or position of the designated signaller. The operator should avoid operating the crane, with or without a load, in this area.

g. The horizontal and vertical distance of movement of long span lines due to the wind shall be added to the minimum clearance distance as specified in Table 15-3. A qualified representative of the the owner of the lines or a designated representative of the electrical utility shall be consulted for specific distances.

h. Devices such as ribbons, balls, etc., should be attached by a qualified person to the power lines to improve visibility, or equivalent means employed to aid in location of the prohibited zone.



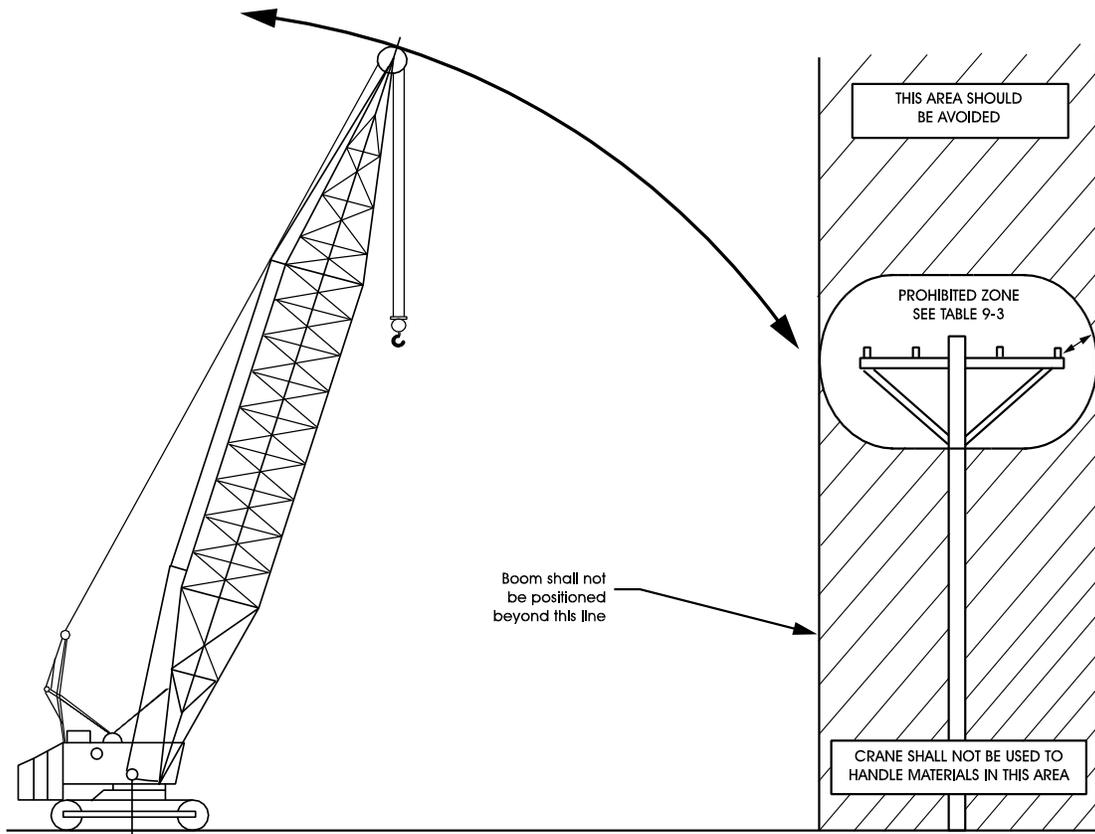
**Figure 15-13. Danger zone for cranes and lifted loads operating near electrical transmission line**

**Table 15-3. Safe working distance from power lines.**

a. When operating near high-voltage power lines:				
Normal voltage (phase to phase)				Minimum required clearance
		to	50 kV	10 ft ( 3.1 m)
Over	50	to	200 kV	15 ft ( 4.6 m)
Over	200	to	350 kV	20 ft ( 6.1 m)
Over	350	to	500 kV	25 ft ( 7.6 m)
Over	500	to	750 kV	35 ft (10.7 m)
Over	750	to	1000 kV	45 ft (13.7 m)

b. While in transit with no load and boom or mast lowered:				
Normal voltage (phase to phase)				Minimum required clearance
		to	0.75 kV	4 ft (1.2 m)
Over	0.75	to	50 kV	6 ft (1.3 m)
Over	50	to	345 kV	10 ft (3.5 m)
Over	345	to	700 kV	16 ft (4.9 m)
Over	750	to	1000 kV	20 ft (6.1 m)



**Figure 15-14. Danger zone for cranes and lifted loads operating near electrical transmission line.**

#### **15.5.2.4.3 Crane Operations are Within the Prohibited Zone and the Power Lines are Energized**

a. Before such operations take place, a qualified person together with a qualified representative of the utility or an engineer qualified in power line transmission shall, after visiting the site, determine if this is the most feasible way to complete the operation, and set minimum required clearances and procedures for safe operations. These operations shall be under their supervision.

The following guidelines should be required:

1. Crane/load grounded to a neutral line by the utility.
  2. Electrical system protective devices that automatically re-energize the circuit after a power line contact occurrence should be blocked or disengaged to inhibit this function.
  3. Insulated barriers, which are not a part of nor an attachment to the crane and which will not allow contact between the energized electric power lines and the crane, load lines, or load.
  4. Non-conductive barricades to restrict access to the crane work area.
- b. Load control, when required, shall utilize tag lines of a non-conductive type.
- c. A designated signaler, whose sole responsibility is to verify that the clearances established are maintained, shall be in constant contact with the crane operator.
- d. The person responsible for the operation shall alert and warn the crane operator and all persons working around or near the crane about hazard of electrocution or serious injury and instruct them on how to avoid the hazard.
- e. All non-essential personnel shall be removed from the crane work area.
- f. No one shall be permitted to touch the crane or the load unless the signaler indicates it is safe to do so.

#### **15.5.2.4.4 Crane in Transit With No Load and Boom Lowered (see Figure 15-15)**

a. Cranes in transit with no load and boom lowered shall maintain clearance as specified in

Table 15-3.

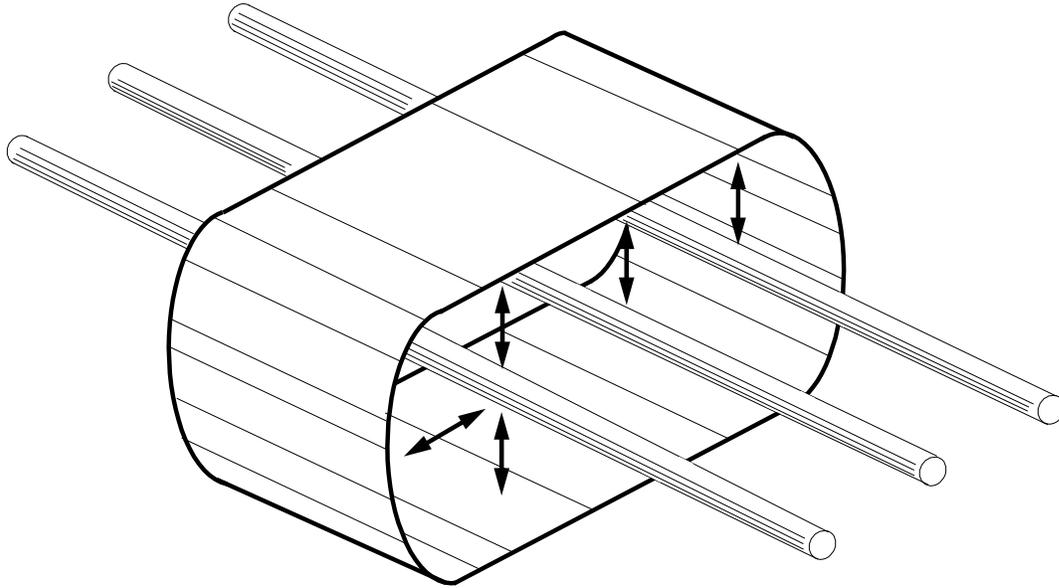
- b. A designated signaler shall be assigned to observe the clearance and give warning before the crane approaches the above limits.
- c. When planning transit of the crane, the effect of speed and terrain on the boom and crane movement shall be considered.

#### **15.5.2.4.5 Crane Operation Near Transmitter Towers (see Figure 15-16)**

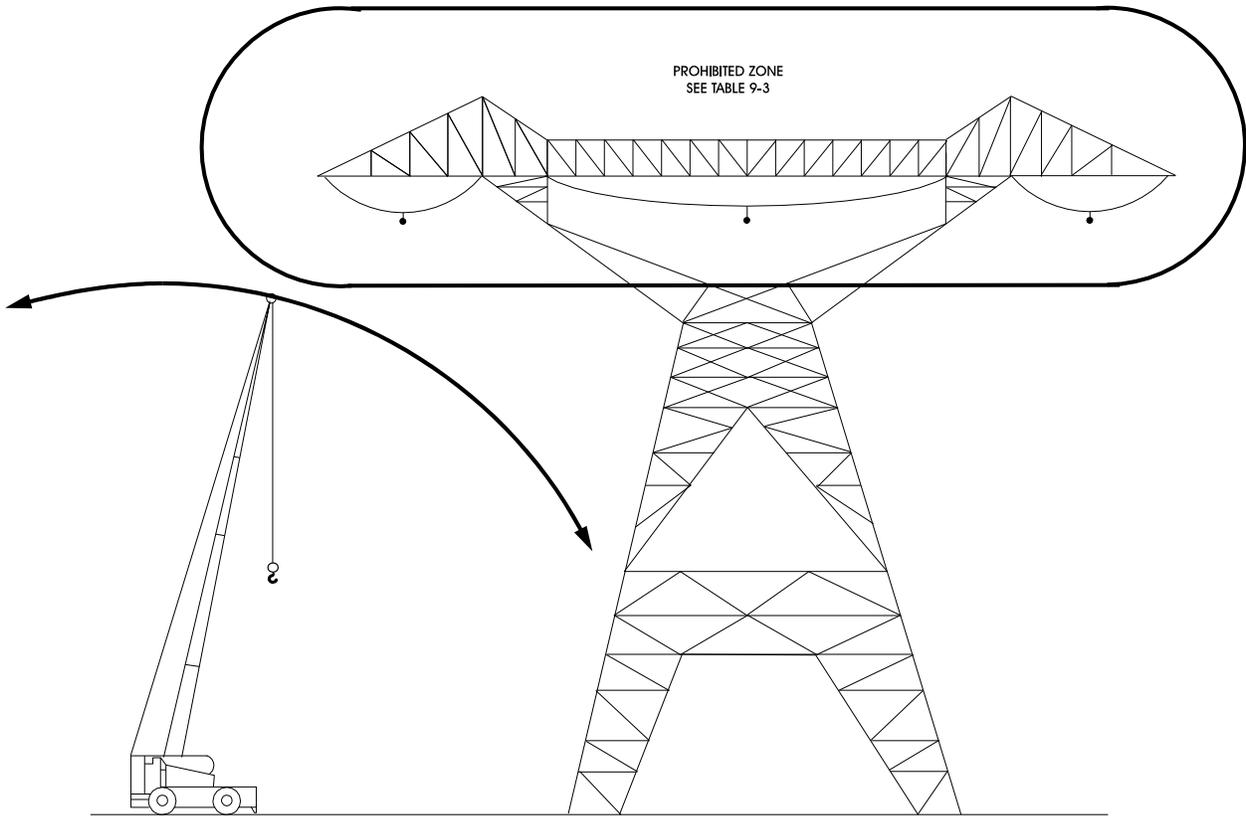
- a. Prior to work near transmitter towers where an electrical charge can be induced in the equipment or materials being handled, the transmitter shall be deenergized or tests shall be made to determine if electrical charge is induced on the crane. The following precautions shall be taken when necessary to dissipate induced voltages:
1. The equipment shall be provided with an electrical ground directly to the upper rotating structure supporting the boom.
  2. Ground jumper cables shall be attached to materials being handled by boom equipment when electrical charge is induced while working near energized transmitters; crews shall be provided with nonconductive poles having large alligator clips or other similar protection to attach the ground cable to the load.
  3. Combustible and flammable materials shall be removed from the immediate area prior to operations.

#### **15.5.2.5 Ordinary Lifts**

- a. An appointed person shall classify each lift into one of the DOE categories (ordinary or critical) prior to planning the lift.
- b. Hoisting and rigging operations for ordinary lifts require a designated leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.
- c. Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the crew's organizational structure.
- d. The designated leader's responsibility shall



**Figure 15-15. Danger zone for cranes and lifted loads operating near electrical transmission line.**  
(See Table 15-3 for minimum radial distance of prohibited zone.)



**Figure 15-16. Danger zone for cranes and lifted loads operating near electrical transmission line.**

include the following:

1. Ensure that personnel involved understand how the lift is to be made.
2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.
3. Survey the lift site for hazardous/unsafe conditions.
4. Ensure that equipment is properly set up and positioned.
5. Ensure that a signaler is assigned, if required, and is identified to the operator.
6. Direct the lifting operation to ensure that the lift is completed safely and efficiently.
7. Stop the job when any potentially unsafe condition is recognized.
8. Direct operations if an accident or injury occurs.

e. The designated leader shall inspect all cranes to ensure that they are still within the inspection interval.

f. The designated leader shall inspect all lifting devices to ensure that the rated capacity of these items of equipment will not be exceeded.

#### 15.5.2.6 Critical Lifts

a. The operating organization shall appoint a person-in-charge (PIC) of the lifting operation. This person shall meet the definitions of appointed, designated, and qualified, as described in Section 15.2, "Definitions."

b. The PIC shall ensure that a pre-job plan is prepared that defines the operation and shall include the following:

1. Identification of the items to be moved, the weight, dimensions, center of gravity, and the presence of hazardous or toxic materials.
2. Identification of cranes to be used by type and rated capacity.
3. Rigging sketches that include (as applicable):

- i. Identification and rated capacity of slings, lifting bars, rigging accessories, and below-the-hook lifting devices.
- ii. Load-indicating devices.
- iii. Load vectors.
- iv. Lifting points.
- v. Sling angles.
- vi. Boom and swing angles.
- vii. Methods of attachment.
- viii. Crane orientations.
- ix. Other factors affecting equipment capacity.

4. Operating procedures and special instructions to operators including rigging precautions and safety measures to be followed as applicable.

c. Only experienced operators who have been trained and qualified to operate the specific equipment to be used shall be assigned to make the lift.

d. Only designated, qualified signalers shall give signals to the operator. However, obey a STOP signal at all times no matter who gives the signal.

e. The responsible manager or designee shall review and approve the procedure and rigging sketches before the lift is made.

#### 15.5.2.7 Lifting Personnel

a. Do not lift, lower, swing, or travel the crane or forklift while a worker is on the hook, load, personnel platform, boom, or personnel-lifting device attached to the crane hoist rope, boom, or tines except as described in the paragraphs below.

b. The person specifically responsible for the overall work function to be performed shall determine that there is no practical alternative machine or equipment to perform the work, such as a ladder, scaffold, stairway, aerial lift, or personnel hoist. If a determination is made that lifting by crane or forklift is required, the construction management contractor shall be

notified and will approve the requirement before the lift is made.

c. Use only personnel platforms that are specifically designed and constructed for the purpose of suspending personnel according to the following:

1. The personnel platform shall be designed by a qualified person competent in structural design, and all welding of the platform shall be performed by a qualified welder familiar with the weld grades, types, and material specified in the design.

2. The platform shall be limited to carrying six persons.

3. The personnel platform and rigging shall be capable of supporting, without failure, at least five times the maximum intended load.

4. The platform shall bear a plate specifying its empty weight and the maximum number of persons and weight for which it is rated.

5. The platform shall have perimeter protection consisting of a top rail approximately 45 in. (115 cm) high, a toeboard at least 4 in. (10 cm) high, and a midrail approximately half-way between the top rail and the toeboard.

6. A grab rail shall be provided inside the personnel platform to minimize hand exposure.

7. The sides of the platform shall be enclosed from the toeboard to the midrail with solid construction or expanded metal having openings no greater than 1/2 in. (1.27 cm).

8. If access doors are installed, they shall open only to the interior of the platform. Access doors shall be equipped with a device to restrain them from opening unintentionally.

9. The personnel platform shall have overhead protection when there is an overhead hazard.

10. Sufficient headroom shall be provided to allow employees to stand upright in the platform.

11. Rough edges exposed to contact by employees shall be surfaced (ground smooth) to prevent injury.

12. The platform shall be easily identifiable by high-visibility color or marking.

13. All welding procedures and welding operator qualifications shall be in accordance with ANSI/AWS D1.1 when welding is to be performed on load-sustaining members. Where special steels or other materials are used, the manufacturer shall provide welding procedures. Welds shall be inspected by a qualified inspector.

14. When being supported by a crane, the platform shall be attached to the hoist rope by a hook of a type that can be closed and locked, eliminating the hook throat opening. Alternatively, an alloy steel anchor shackle with a bolt, nut, and retaining pin may be used.

15. All eyes in wire-rope slings shall be fabricated with thimbles, and rigging accessories for attaching the personnel platform to hoist lines shall not be used for any other purpose when not hoisting personnel.

16. The suspension system shall minimize inclination of the personnel platform due to the movement of personnel on the personnel platform.

d. At each new job site (and at least annually) prior to hoisting personnel, the personnel platform, rigging, and hook block shall be proof-tested by a qualified inspector to twice the personnel platform's rated capacity by holding it suspended for 5 min with the test load suitably distributed on the personnel platform. After proof-testing, any deficiencies revealed by inspection, or by the proof test, shall be corrected, and another proof test conducted. Any modification to the personnel platform or rigging shall require retesting.

e. Prior to the trial lift, a meeting shall be held with the designated leader, qualified operator, signaler, persons to be lifted, and the person responsible for overall worksite safety to plan and review procedures to be followed. Procedures for entering and leaving the personnel platform or other device and the points at which persons will enter and leave the device shall be reviewed.

f. Prior to lifting personnel and after the proof test, the qualified operator and signaler shall conduct a trial lift with the personnel platform loaded to at least the anticipated load.

g. The trial lift shall be made from ground level (or any other location where employees will enter

the platform) to each location at which the platform is to be hoisted and positioned. The designated leader and the operator shall determine that:

1. Crane (mobile) footing is adequate.
2. System controls and safety devices are activated and functioning properly.
3. No interferences exist.
4. Configuration necessary to reach work locations will allow the crane to remain under 50 percent of rated capacity.

NOTE: Materials and tools to be used during the actual lift, if secured to prevent displacement, can be in the platform for the test lift.

NOTE: A single trial lift may be performed for all locations to be reached from a single setup position.

h. The trial lift shall be repeated prior to hoisting employees whenever:

1. The crane (mobile) travels or is moved and set up in a new location or returned to a previously used location.
2. The lift route is changed, unless the operator determines that the safety of the hoisted personnel is not affected.

i. A visual inspection of the crane, rigging, and personnel platform shall be conducted by a qualified inspector immediately after the trial lift, prior to lifting personnel. Any defects found that create a safety hazard shall be corrected prior to hoisting personnel.

j. After the trial lift and just before hoisting personnel, the platform shall be lifted a few inches and inspected to ensure that it is secure and properly balanced. Personnel shall not be hoisted unless the following conditions exist:

1. Hoist ropes are free of kinks.
2. Multiple-part lines are not twisted around each other.
3. The primary attachment is centered over the platform.
4. Ropes are properly seated on drums

and sheaves.

k. These special procedures shall be followed when lifting personnel:

1. The crane shall be inspected daily prior to lifting personnel, in accordance with the requirements for frequent inspections for the type of equipment being used.

2. The lifting and supporting shall be made under controlled conditions and under the direction of a designated leader. A qualified signaler shall be appointed.

3. Prior to each working shift, the personnel lift platform and rigging shall be inspected.

4. Communications between the crane operator, signaler, and persons being lifted shall be maintained throughout the lift.

5. The employees being hoisted, moved, or positioned shall remain in continuous sight of, and in direct communication with, the operator or signaler. In situations where direct visual contact with the operator is not possible and the use of a signaler would create a hazard for that person, direct communication alone (such as two-way radio) may be used.

6. Tag lines shall be used unless their use creates an unsafe condition.

7. The crane shall be operated so that lowering will be power-controlled (no free-fall).

8. When welding is done by personnel from the platform or basket, the electrode holders shall be protected from contact with metal components of the personnel platform or basket.

9. Employees working from a platform shall wear body belts/harnesses with lanyards attached to the lower load block or overhaul ball, or to a structural member within the platform that is capable of supporting a fall impact. When working above water, the requirements of 29 CFR 1926.106 (Occupational Safety and Health Regulations for Construction) shall also apply.

10. The operator shall remain at the controls when the personnel platform is occupied.

11. Movement of the personnel platform shall be done in a slow, controlled, cautious

manner with no sudden movements of it or the crane. the lifting or lowering speed shall not exceed 100 ft/min (30 m/min).

12. The total weight of the lifted load (including personnel) shall not exceed 50 percent of the crane rating under the planned conditions of use.

13. Suspended personnel platforms shall be used only for personnel, their tools, and sufficient materials to do their work. They should not be used for transporting bulk materials.

14. Personnel shall keep all parts of their bodies inside the suspended personnel platform during raising, lowering, and positioning to avoid pinch points. Personnel shall not stand on or work from the top rail, midrail, or toeboard of the suspended personnel platform.

15. If the personnel platform cannot be landed, it should be tied to the structure before personnel get off or on.

16. Personnel platforms should not be used in winds greater than 15 mph (25 km/h), electric storms, snow, ice, sleet, or other adverse weather conditions that could affect the safety of personnel.

17. After the personnel platform is positioned, all brakes and locks on the lift crane shall be set before personnel perform any work.

18. Cranes and derricks with variable-angle booms shall be equipped with a boom-angle indicator that is readily visible to the operator.

19. Cranes with telescoping booms shall be equipped with a device to indicate clearly to the operator, at all times, the boom's extended length, or an accurate determination of the load radius to be used during the lift shall be made prior to hoisting personnel.

20. A positive-acting device shall be used that prevents contact between the load block or overhaul ball and the boom tip (anti-two-blocking device), or a system shall be used that deactivates the hoisting action before damage occurs in the event of a two-blocking situation (two-block damage-prevention feature).

21. The crane shall be uniformly level within 1 percent of level grade and located on firm

footing.

22. Cranes shall not travel while personnel are on a personnel platform or in the basket.

23. Cranes with outriggers shall have the outriggers fully extended and blocked.

### 15.5.3 Forklift Trucks

a. Know the rated capacity of the forklift and always operate within that capacity. Since the load rating for forklifts may be based on stability or hydraulic/structural competence, the rated capacity shall not be exceeded in operational application. Signs of tipping shall never be used to determine if a load is within the forklift's capacity.

b. Before operating electric-powered machines, check location of the battery plug for quick disconnection in case of a short circuit.

c. Ensure that battery recharging and maintenance takes place in designated areas where smoking, sparks, or open flames are prohibited. Wear eye protection, rubber gloves, and rubber aprons. Whenever battery maintenance is performed, any area of the body affected by contact with battery electrolyte shall be flushed with water immediately and all acid spills must be cleaned up at once.

d. Ensure that fueling of internal-combustion-powered forklift trucks takes place in designated areas. The vehicle engine must be turned off and smoking, sparks, or open flames shall be prohibited.

e. Handling liquefied petroleum gas (LPG) fuel presents a unique hazard. Therefore, to avoid injury while refueling with LPG fuel, precisely follow the refueling procedure in the operator's manual for the vehicle.

f. The operation of internal combustion-powered forklift trucks in confined spaces shall be prohibited unless special precautions are followed to preclude the buildup of carbon monoxide gas above prescribed levels.

g. Only qualified operators shall be permitted to operate forklift trucks. No one shall operate the equipment other than the person to whom it is assigned.

h. Report and correct any apparent mechanical deficiencies before operating the forklift truck.

### 15.5.3.1 Operating the Unit

a. Forklift truck operators shall do the following:

1. Before operation of electrically powered machines, check location of the battery plug for quick disconnection in case of a short circuit.

2. Avoid sudden stops.

3. Face in the direction of travel, except as follows:

i. For better vision with large loads, operate the truck in reverse gear.

ii. When ascending or descending grades in excess of 5 percent, drive loaded rider trucks with the load upgrade.

iii. Operate unloaded trucks on all grades with the load-engaging means downgrade.

4. Stop and sound the horn at all blind corners and intersections and when going through doorways.

5. Operate at safe speeds: in-plant buildings, 5 mph; in-plant roads, 15 mph maximum.

6. Go around curves slowly.

7. Use low gear or slowest speed when descending ramps.

8. Do not allow riders on forklift trucks unless the truck is built with passenger seating.

9. Know the weight of the load and do not exceed the rated capacity of the truck.

10. Consider both truck and load weight when traveling in areas where there are floor-loading requirements.

11. Watch overhead clearance; if in doubt, measure.

12. Keep clear of edges of loading docks.

13. Watch rear-end swing.

14. Before handling them, ensure that stacks and loads are stable; block and lash them if necessary.

15. Always spread the forks to suit the load width.

16. Lower and raise the load slowly; make smooth, gradual stops.

17. Lift and lower loads only while the vehicle is stopped.

18. Use special care when high-tiering; return the lift to a vertical position before lowering the load.

19. Lift, lower, and carry loads with the upright vertical or tilted back—never forward; on all grades, the load and load-engaging means shall be tilted back.

20. To avoid injury, keep arms and legs inside the operator's area of the machine.

21. Never travel with forks raised to unnecessary heights; approximately 4 to 6 in. above floor level is adequate.

22. When loading trucks or trailers, ensure that the wheels are chocked and the brakes set; place loads in front end of the semitrailer only if the tractor is attached or adequate trailer (railroad) jacks are in place.

23. Inspect floors on trucks, boxcars, unfamiliar ramps, or platforms before starting operation.

24. Be sure bridge plates into trucks or freight cars are sufficiently wide, strong, and secure; portable and powered dockboards shall be conspicuously marked with carrying capacity.

25. Never butt loads with forks or rear end of truck.

26. Remember that forklift trucks should not be used as tow trucks unless a towing hitch approved by the manufacturer is used.

27. Stop engine before refueling.

28. Use only approved explosion-proof lights to check gas-tank and battery-water levels;

*smoking is not permitted* during this operation.

29. Place forks flat on the floor when the truck is parked.

30. Turn ignition switch to OFF position when leaving the machine.

31. Always set brakes before leaving the truck.

32. Report evidence of faulty truck performance.

33. When exiting or leaving the truck, step down—do not jump.

34. Report all accidents promptly to the supervisor.

35. Use guides and signalers as much as possible; if in doubt, check personally before proceeding; the final responsibility for the handling of a truck remains with the driver.

36. Never lift with one fork without an engineering analysis and approval.

37. Do not use the lifting forks as a personnel elevator unless an approved personnel platform securely attached to the forks is used (see Section 15.5.3.5, “Lifting Personnel”).

38. The final responsibility for the handling of a truck remains with the driver. Use guides and signalers as much as possible. Standard signals shall be specified in the latest edition of applicable ASME B.56.1 codes and standards. Signals most commonly used are shown in Figure 15-17.

### 11.5.3.2 Moving the Load

a. The nature of the terrain and the surface on which the truck is to operate are very important factors in the stability of forklift-truck systems. The designated person shall ensure that a proper

truck has been selected to operate on the surface available. In general, small, three-wheeled trucks should operate on smooth, hard surfaces only and are not suitable for outdoor work.

b. The designated person shall ensure that the load is well secured and properly balanced before it is lifted.

c. During hoisting, ensure that:

1. There is no sudden acceleration of the load.

2. The load does not contact any obstruction.

### 15.5.3.3 Ordinary Lifts

a. An appointed person shall classify each lift into one of the DOE categories (ordinary or critical) before the lift is planned.

b. Hoisting and rigging operations for ordinary lifts require a designated leader who shall be present at the lift site during the entire lifting operation. If the lift is being made by only one person, that person assumes all responsibilities of the designated leader.

c. Leadership designation may be by written instructions, specific verbal instructions for the particular job, or clearly defined responsibilities within the crew's organizational structure.

d. The designated leader's responsibility shall include the following:

1. Ensure that personnel involved understand how the lift is to be made.

2. Ensure that the weight of the load is determined, that proper equipment and accessories are selected, and that rated capacity is not exceeded.

3. Survey the lift site for hazardous/unsafe conditions.

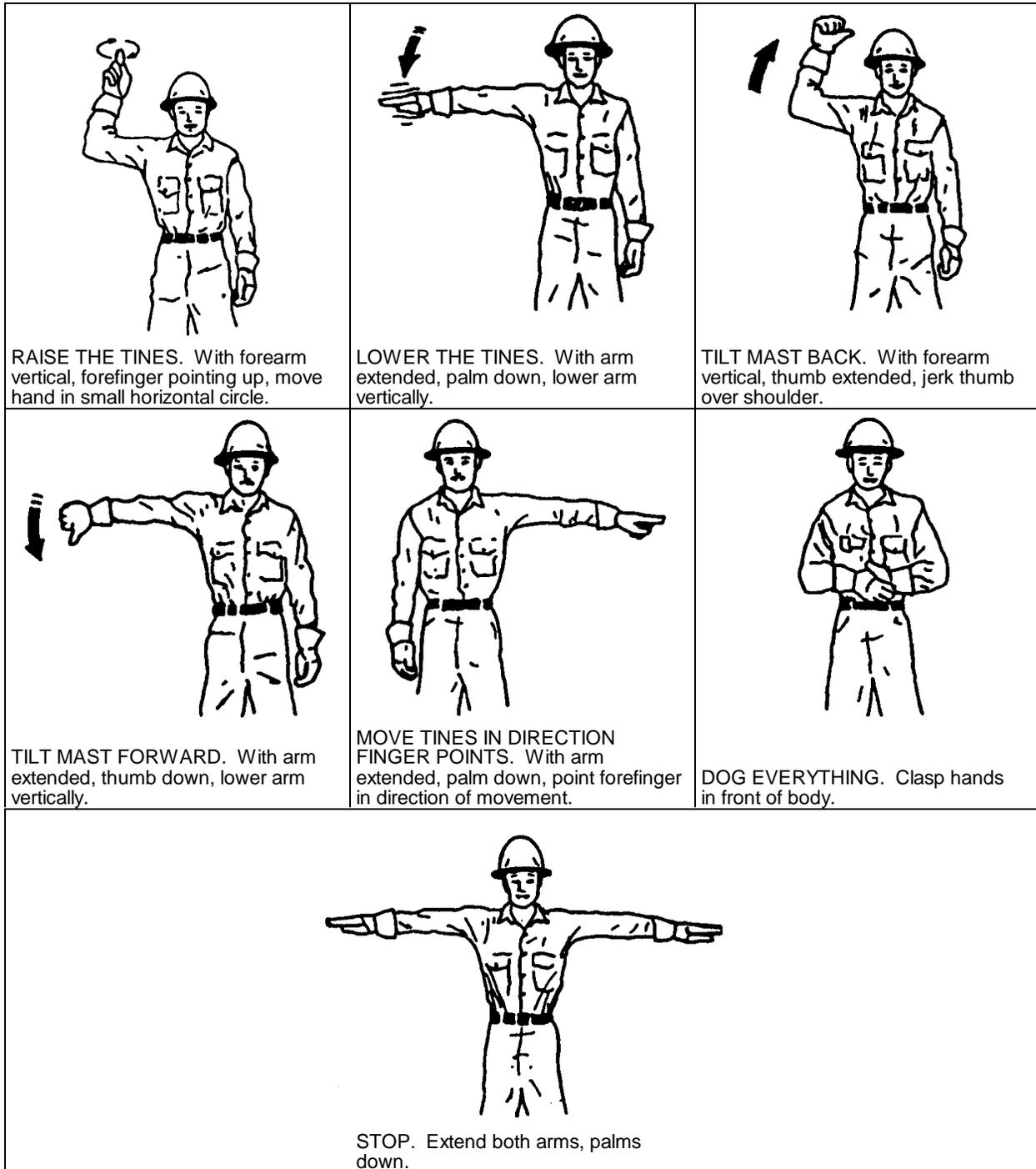


Figure 15-17. Standard hand signals for controlling forklift operation.

4. Ensure that equipment is properly set up and positioned.

5. Ensure that a signaler is assigned, if required, and is identified to the operator.

6. Direct the lifting operation to ensure that the lift is completed safely and efficiently.

7. Stop the job when any potentially unsafe condition is recognized.

8. Direct operations if an accident or injury occurs.

#### 15.5.3.4 Critical Lifts

a. The operating organization shall appoint one PIC of the lifting operation. This person shall meet the definitions of appointed, designated, and qualified, as described in Section 15.2, "Definitions."

b. The PIC shall ensure that a pre-job plan is prepared that defines the operation and shall include the following:

1. Identification of the items to be moved, the weight, dimensions, center of gravity, and the presence of hazardous or toxic materials.

2. Identification of forklifts to be used by type and rated capacity.

3. Rigging sketches that include (as applicable):

- i. Identification and rated slings, lifting bars, rigging accessories, and below-the-hook lifting devices.
- ii. Load-indicating devices.
- iii. Load vectors.
- iv. Lifting points.
- v. Sling angles.
- vi. Boom and swing angles.
- vii. Methods of attachment.
- viii. Forklift orientations.
- ix. Other factors affecting

equipment capacity.

4. Operating procedures and special instructions to operators including rigging precautions and safety measures to be followed as applicable.

c. Only experienced operators who have been trained and qualified to operate the specific equipment to be used shall be assigned to make the lift.

d. Only designated, qualified signalers shall give signals to the operator. However, obey STOP signal at all times no matter who gives the signal.

e. The responsible manager or designee shall review and approve the procedure and rigging sketches before the lift is made.

#### 15.5.3.5 Lifting of Personnel

Take the following precautions whenever personnel are elevated with a forklift truck:

a. Use a lift platform manufactured for the purpose of lifting personnel with a forklift truck that meets the requirements of ASME B56.1.

b. Ensure that a restraining means (handrails or chains) exists that is capable of withstanding a force of 200 pounds in any direction; if no restraining means is provided, personnel on the platform shall wear a body harness with lanyard or deceleration device.

c. When being supported by a forklift, the personnel platform shall be attached in such a manner that it cannot slide or bounce off the forks.

d. The operator shall remain in the control position of the forklift truck or means shall be provided whereby personnel on the platform can shut power off to the forklift truck.

e. Overhead protection, as indicated necessary by operating conditions, shall be provided.

f. Means shall be provided to protect personnel from moving parts of the forklift truck that present a hazard when the personnel platform is in the normal working position.

g. Do not transport personnel from one location to another while they are on the work platform.

h. Provide 4-in. (10-cm) toeboards on the work platform.

i. Whenever a truck (except for high-lift order-picker trucks) is equipped with vertical hoisting controls elevatable with the lifting carriage or forks, take the following additional precautions to protect personnel:

1. Means shall be provided whereby personnel on the platform can shut off power to the truck.

2. Means shall be provided to render inoperative all operating controls, other than those on the elevating platform, when the controls on the elevating platform have been selected for use; only one location of controls shall be capable of being operated at one time.

3. Emergency lowering means available at ground level should be provided; such means, when provided, shall be protected against misuse.

# CHAPTER 16

## REFERENCES

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AISC Specifications for the design, fabrication, and erection of structural steel for buildings.

### American Iron and Steel Institute

AISI Standards for Type-302 or Type-304 stainless steel.

### American National Standards Institute

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ANSI A10.18-1983, Floor and Wall Openings, Railings and Toe Boards.

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ASME B56.11.4-1992, Forks and Fork Carriers for Powered Industrial Fork Lift Trucks, Hook Type.

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ASME HST-2M-1989, Performance Standard for Hand Chain Manually Operated Chain Hoists.

ANSI/ASME HST-3M-1991, Performance Standard for Manually Lever Operated Chain Hoists.

ANSI/ASME HST-4M-1991, Performance Standard for Electric Wire Rope Hoists.

ANSI/ASME HST-5M-1991, Performance Standard for Air Chain Hoists.

ANSI/ASME HST-6M-1986, Performance Standard for Air Wire Rope Hoists.

ANSI MH 27.1-1981, Specifications for Underhung Cranes and Monorail Systems.

ANSI N14.6-1993, Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials.

ANSI/ASME NQA-1-1989, Quality Assurance Program Requirements for Nuclear Facilities.

ASME NOG-1-1989, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

1a - 1990

1b - 1992

## American Society for Nondestructive Testing

Recommended Practice No. ASNT-TC-1A.

## American Welding Society

ANSI/AWS D1.1 - 1994 Structural Welding Code—Steel.

## Crane Manufacturers' Association of America

CMAA No. 70-1994, Specification for Electric Overhead Traveling Cranes.

CMAA No. 74-1987, Specification for Top Running and Under Running, Single Girder, Electric Overhead Traveling Cranes.

## Department of Energy

DOE 5480.4, Environmental Protection, Safety, and Health Protection Standards.

Change 3 - 9-20-91

## Department of Labor

29 CFR 1910, Occupational Safety and Health Standards for General Industry.

29 CFR 1926, Occupational Safety and Health Regulations for Construction.

## Department of Transportation

49 CFR 391.41, Physical Qualification for Drivers.

## National Fire Protection Association

ANSI/NFPA 505-1987, Powered Industrial Trucks, Type Designation and Areas of Use.

NFPA 70, National Electrical Code.

## **Power Crane and Shovel Association**

PCSA-4, Mobile Power Crane and Excavator Standards and Hydraulic Crane Standards.

## **Society of Automotive Engineers**

SAE J376-85, Load-Indicating Devices in Lifting Crane Service.

SAE J765-1990, Crane Load Stability Test Code.

SAE J874-1986, Center of Gravity Test Code.

SAE J987-1985, Crane Structure, Method of Test.

## **Underwriters' Laboratories**

UL 558-1991, Internal-Combustion-Engine-Powered Industrial Trucks.

UL 583-1991, Electric-Battery-Powered Industrial Trucks.

INTENTIONALLY BLANK

**CONCLUDING MATERIAL**

**Review Activity:**

<u>DOE</u>	<u>Field Offices</u>
DP	CH
EH	ID
EM	NV
RW	OR
ER	RL
	SR

**Preparing Activity:**

DOE-EH-51

**Project Number:**

SAFT-0034

National Laboratories

FERMILAB

INEL

ORNL

Area Offices

Amarillo Area Office

Princeton Area Office